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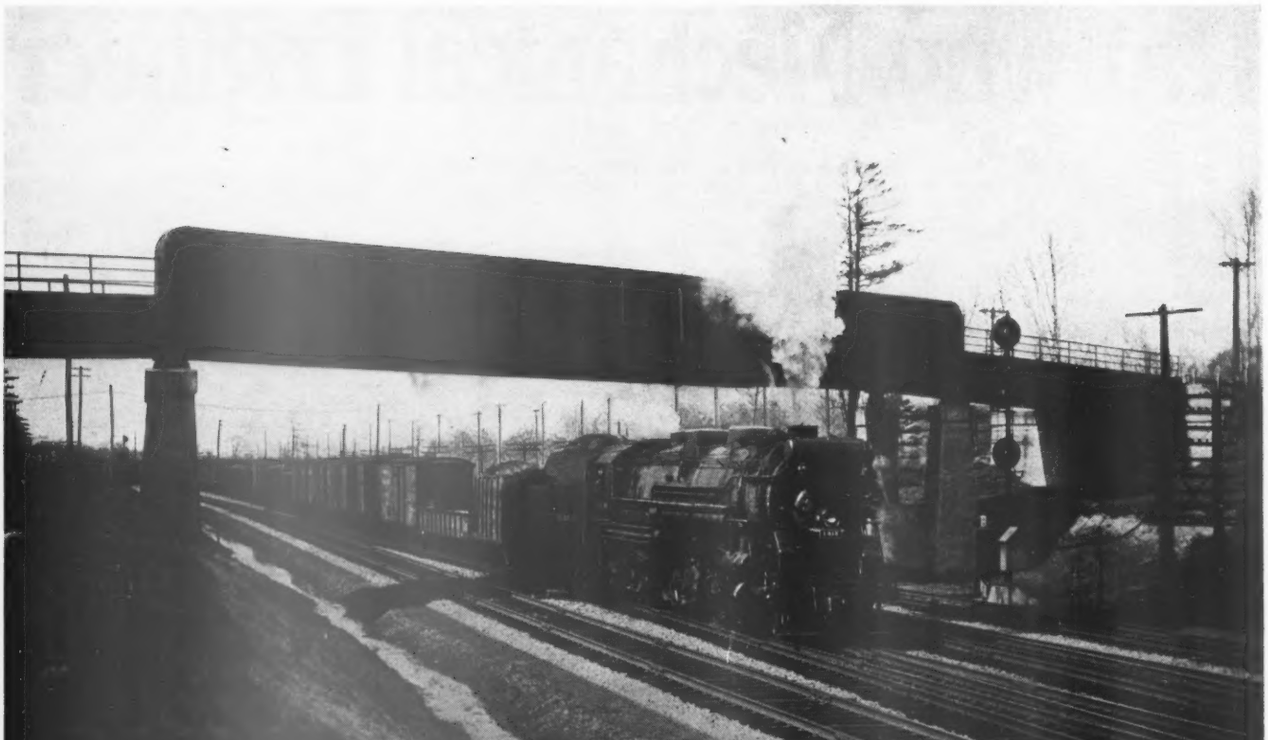

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December - 1935

Santa Fe Gets Largest Diesel Locomotive

Description of the double-unit locomotive which develops 3,600 rated horsepower and recently made a record run from the Pacific coast to Chicago

A 3,600-hp. Diesel-electric locomotive, designed by the Electro-Motive Corporation, a General Motors subsidiary, and built at the St. Louis plant of the St. Louis Car Company, has recently been delivered to the Atchison, Topeka & Santa Fe. It is the largest and most powerful locomotive yet arranged to be driven by internal combustion engines, although a similar Electro-Motive double-unit locomotive of the same power is now being tested on a number of roads and a single-unit locomotive of the same design, and developing one-half the power, is in service on the Baltimore & Ohio.

The Santa Fe Diesel-electric locomotive is a multiple unit of two identical sections. The complete locomotive is 127 ft. 8 in. long between coupler-pulling faces, weighs 250 tons and has a tractive force of 120,000 lb. at starting and 19,000 lb. at a speed of 60 m.p.h. The width overall is 9 ft. 9⅝ in., height overall 14 ft. 3 in., truck wheel base 8 ft. 6 in., truck centers 40 ft., and wheel diameter 36 in.

The two locomotive units are streamlined, for appearance, with sloping ends, and all apparatus concealed. A skirt extends around the locomotive, blending the pilots in graceful contours. The headlights also are streamlined, being built into curved receivers in the roof of each unit. The superstructure is constructed of steel shapes and Cor-Ten rolled plates, riveted and welded together.

The locomotive is arranged for double-end operation with an operator's cab at each end of each unit. The engine-room compartment is separated from these cabs

The 3,600-hp. Diesel-electric locomotive recently delivered to the Santa Fe by the Electro-Motive Company

by steel partitions fitted with swinging doors, the partitions being located back of the cab side entrances to afford easy entrance and exit from each operator's compartment. All windows in the operators' cabs are glazed with safety-glass. Front windows are equipped with windshield wipers and cab side windows have sliding and drop sashes. The control station of each cab is located so as to afford the operator a clear view of both sides of the track for the greatest safety and ease of operating the locomotive.

The engine compartment is designed to provide ease in inspection and maintenance of all equipment, ample room being provided around the various pieces of apparatus. Aisleways extend from cab to cab along both sides of the locomotive and are free from obstruction. Large drop sash windows provide ample light. The roof above the engine compartment is made up of removable sections to facilitate replacement of the larger pieces of apparatus when necessary.

The underframe is a Commonwealth one-piece steel casting with end sills cast integral and designed to withstand all stresses to which it will be subjected in ordinary service. At all points where stresses occur, extra ribbing has been provided. Suitable openings are provided for

One of the Winton 900-hp. Diesel power units in the engine room

piping, wiring and conduit. Two four-wheel swivel trucks, with 36-in. wheels and 6½-in. by 12-in. plain journals, support the underframe on 18½ in. center plates spaced 40 ft. apart. The wheelbase of each truck is 8 ft. 6 in. The truck frames are of the swing bolster type with Commonwealth cast-steel frames.

The locomotive is equipped with Westinghouse 8-EL straight and automatic brake schedule, modified to permit the installation of a continuous train control system. Clasp brakes are fitted to all wheels and are operated by four brake cylinders per truck. Sand boxes are located in the engine room for sanding the front wheels of the leading truck.

The steam generator provided in each unit for heating and air-conditioning the trailing cars was designed especially for this locomotive by the Vapor Car Heating and Lighting Company. It is a light-weight, compact, automatic unit and draws its fuel from the same storage tanks that supply the power plant. It has an evaporation capacity of 2,000 lb. of water per hour and a working pressure of 200 lb. The locomotive boiler-water capacity is 1,250 gal., provided in four rectangular tanks hung symmetrically about the center lines outside the center sills. These tanks are heavily insulated to prevent the water from freezing in cold weather. They have a common water filling manifold fitted into the car roof in the center of the locomotive. By lifting the hatch cover to this manifold, the water tanks may be filled from a regular water crane.

The Power Plant

Motive power of each unit is supplied by two 900-hp. oil-electric power plants mounted on the underframe directly over each center plate. The combined rating of these two power plants is 1,800 hp., a total of 3,600 hp. for the two units, and all of this power, except for necessary losses in transmission, is available for traction purposes. The power required by auxiliaries is supplied either by the auxiliary engine or taken from the main engines in excess of their rating.

The main engines comprise two Winton V-type, 12-cylinder high-compression two-cycle oil engines of 8-in. bore and 10-in. stroke. Each of the engines is conservatively rated at 900 hp. at 750 r.p.m. These engines are extremely light in weight, weighing less than 20 lb. per hp., this notable saving in weight over the usual type of Diesel engine being effected by incorporating several improved features of construction. Among these are the uniflow principle of scavenging, which permits the use of a two-cycle stroke at greater efficiency than is generally obtained in engines of this type, and the welded steel crankcase construction, which is stronger than the usual cast-iron frame at a great saving in weight.

A feature of note is the patented unit injection valves which assure a complete atomization of fuel in the cylinders. All working parts are readily accessible without dismantling the engine. Convenient hand-hole covers permit access to the connecting rods and main bearings. Cylinders have individual heads and removable liners. All working parts are designed to require a minimum of maintenance, and also to permit required maintenance being done in the average railroad shop with its present equipment and personnel.

Each engine cooling system consists of a series of fin-tube radiators, water circulating pump, and air circulating fans for radiator cooling. The cooling radiators are arranged in two long sections of coupled units, hung parallel to the power plant and supported by the under side of the engine compartment roof. Each engine receives its water from a common supply tank, located in the center of the car below the level of the radiators to permit self-draining of the radiators during cold weather. Provision has been made to keep this water warm when the locomotive is not in service by admitting steam from the heating system into the engine water jackets.

Air is drawn into the engine compartment through grilled openings at each end of the locomotive, and forced by means of large engine-driven fans through the radiators. After passing through the radiators, the air leaves the locomotive through a series of vents opening into the exhaust-manifold well in the roof.

Method of Lubrication

The lubricating-oil system of each engine consists of a supply tank, a water cooler, circulating pumps, strainers and filters. Two pumps, one at each end of the engine

crankcase, are fitted with removable strainers. A dual scavenging pump draws the hot oil from these pumps and passes it through a large capacity water-jacketed oil cooler to the oil-supply reservoir. Here it is filtered, and then taken back to the engine by means of a pressure pump. The pressure is regulated by a relief valve. Provision is made on the engine to close the engine throttle in the event of deficient oil supply.

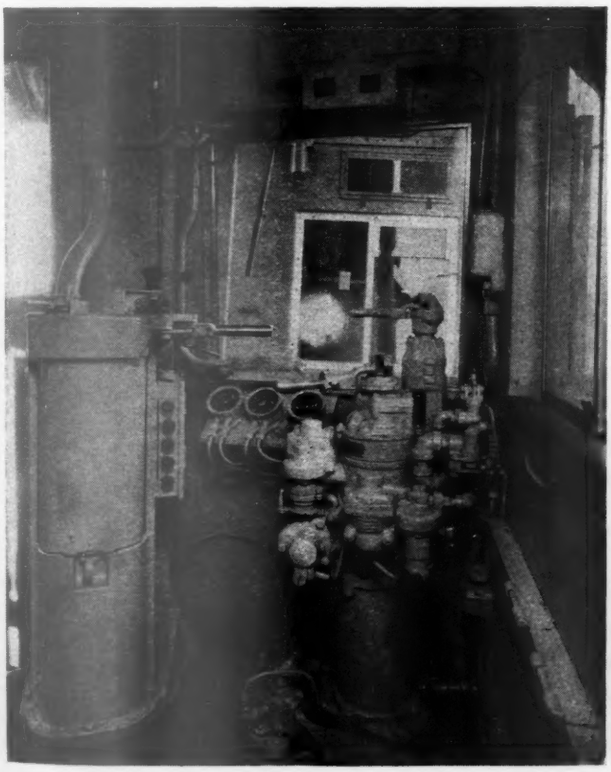
Fuel for the engines is carried in two 400-gal. storage tanks located under each unit, a total of 1,600 gal. for the two units. These tanks are equipped with efficient strainers and filling manifolds to provide quick refueling without elaborate equipment, and can be filled from either side of the locomotive. Fuel is delivered to the engines by means of motor-driven fuel pumps. A 25-lb. pressure head, maintained on the fuel header, is regulated by a spring-loaded by-pass valve which empties into the fuel tanks.

An exhaust muffler is mounted in a well located in the roof over each engine. Individual stacks from each cylinder terminate in this muffler, which vents to the outside through four stub riser pipes welded in the top. This muffler is designed to prevent the pocketing of fumes and also to reduce exhaust noise to a minimum.

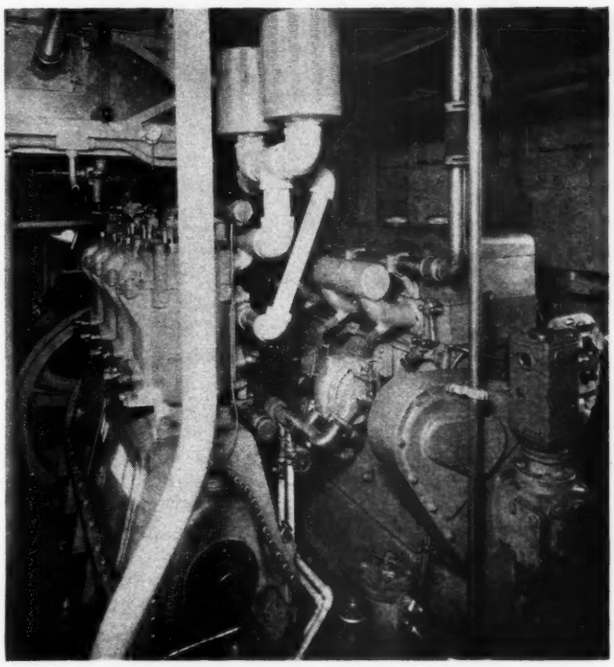
In the center of each unit is a group of three auxiliaries, all driven by a single 6-cyl., 90-hp. Diesel engine. The auxiliaries are the air compressor, battery-charging generator, and traction-motor blower fan.

The Winton air compressor is a 4-cyl., 2-stage, water-cooled unit, with a displacement of 158 cu. ft. per minute. This supply of air is continuous regardless of running speed, as the auxiliary engine speed is constant. The compressor is equipped with governors which control an unloader on the compressor to maintain the required pressure in the air reservoirs.

A 10-kw. generator is supplied to charge the storage battery. This generator, with its control, provides a constant-potential source of energy for battery charging sufficient for all conditions which this equipment is used.



Arrangement of control equipment at one of the operator's stations



Auxiliary power-equipment located in one of the locomotive engine rooms

The third unit of this auxiliary group is a centrifugal blower which supplies air to the traction motors via the air ducts provided in the underframe.

Electrical Transmission

An independent electrical transmission, furnished by the General Electric Company, is provided for each engine to the two driving axles immediately below that engine. Each transmission equipment consists essentially of a generator, two traction motors, and control contactors for connecting the motors to the generator in the proper sequence and for reversal of direction of motion. There are no mechanical or electrical connections between the two power plants other than an electric throttle and controller which control both units from either end of the locomotive.

Each engine is directly connected through a flexible coupling to a direct-current generator. Each generator has sufficient capacity to transmit continuously to the traction motors the rated output of the engine for which this equipment is offered. The exciter for each generator is mounted on an extension of the generator shaft and is used solely for excitation purposes.

Four traction motors of the G. E. railway series type are provided, two mounted on each truck. Each traction motor is geared to a pair of driving wheels and supported by a spring nose suspension to protect it against undue strain.

The multiple-unit control system used on this locomotive has been so designed that any number of units may be coupled together and be controlled from one operator's station. This provides a great range of flexibility, as units can be added when traffic conditions require additional power.

The entire control system centers around a trunk line extending from one end of the locomotive to the other and terminating at each end in a plug socket from which a jumper may be used to carry the trunk lines to the next locomotive if more than one locomotive is to be

(*Continued on page 495*)

Roller-Bearing Rods in Passenger Service Over a Year

Timken design on Pennsylvania Pacific type includes all revolving and reciprocating parts. The use of high-tensile steel reduces weights

THE first complete installation of roller-bearing rods was placed in service on Locomotive No. 5371, a K4S Pacific type, of the Pennsylvania Railroad, on July 4, 1934. This installation, developed by the Timken Roller Bearing Company, has made approximately 100,000 miles in regular passenger service between Pittsburgh, Pa., and Columbus, Ohio.

Locomotive No. 5371 is also completely equipped with roller-bearing axles. The engine truck is provided with the standard Timken engine-truck boxes. The driving and trailer boxes, however, were designed to replace the plain-bearing boxes for which the locomotive was originally designed without major changes in the truck and frame construction.

The bearing installation required a complete redesign of rods and crank pins which also included the crosshead, piston rod and piston head. High-tensile alloy steel as employed in the new design effected a material reduction in weight of the reciprocating parts and weights on the crank pin. At the same time this new design provides the close bearing tolerances required for successful roller-bearing performance combined with the flexibility of rod alignment necessary in locomotive service.

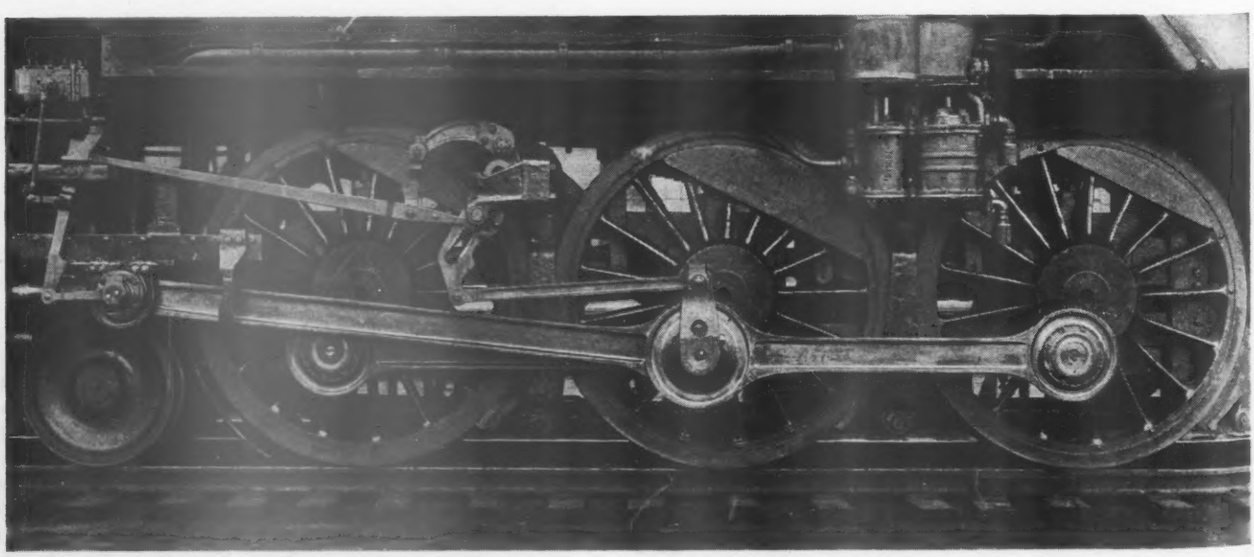
The outstanding features of the new design are: (1) The mounting of the roller bearings on crank pins; (2) fitting of the rods to the bearings; (3) complete separation of the front and back sections of the side rods; (4) application of the main rod on the outer race of the main-pin bearing between the ends of the two side rods; (5) use of a crosshead having shoes pivoted around the crosshead pin, thus relieving the piston rod, of eccentric loading from the guides. The piston, piston rod, the piston-rod key, crosshead forging, cross-head pin, main rod, side rods and crank pins are all of Timken High Dynamic steel, a chrome-nickel-molybdenum alloy heat treated to produce an elastic limit of about 110,000 lb. per sq. in., an ultimate strength of 140,000 lb., with 22 per cent elongation in 2 in., a Brinell hardness of 293, and possessing high shock resisting qualities.

The Crank-Pin Bearings

All bearings are fitted on the crank pins and not in the rods. On the main crank pin the bearing consists of two sets of rollers, each fitted in a separate cone. A portion of the inner cone and pin is tapered, ending in a 6¾-in. cylindrical fit toward the outer end of the cone. The cone at the outer end of the pin has a cylindrical fit on the pin 6 in. in diameter. Around the pin taper between the two fits is a spacer between the bearing cones. Both sets of rollers are enclosed by a single cup or outer race.

The eyes of the rods, which are specially forged I-sections, bear directly on the cup, which is 13½ in. in outside diameter. The rod bushings are of unusual design, each consisting of a ⅛-in. strip of hard rolled phosphor-bronze, bent to shape, brazed, and pressed into the eye of the rod. A considerable reduction in rod weight is thus effected. The bores of the bushings are finished with a slight crown to provide the necessary freedom of angular movement of the rods on the bearing.

The front side rod is placed on the main-pin bearing next to the wheel. Between this and the main rod is a light cylindrical spacer $3\frac{15}{16}$ in. wide. The back side rod is placed next to the main rod at the outer end of the bearing. A normal clearance of $\frac{1}{32}$ in. is provided between each pair of adjoining surfaces for lateral move-



Running gear of Pennsylvania locomotive No. 5371

ment of the rods on the pin. This is somewhat increased on the side of the pin opposite the body of each rod by a slight taper in the width of the rod end to prevent cramping under angular movement of the rods with respect to their normal alignment at right angles to the center line of the crank pin. The overall length of the bearing cup is $10^{11}\frac{1}{16}$ in. Side-rod bearings are each 1½ in. in length and the main-rod bearing 3 in. long.

The bearings on the front and back crank pins are made up of two sets of tapered rollers running in separate cones which are pressed on the 5-in. crank-pin fit. As in the case of the main crank pin, the bearing is completed by a single cup 11½ in. in outside diameter, on which bears the bronze-bushed eye of the side rod. The overall length of the bearing, including the end enclosures, is 4⅞ in.

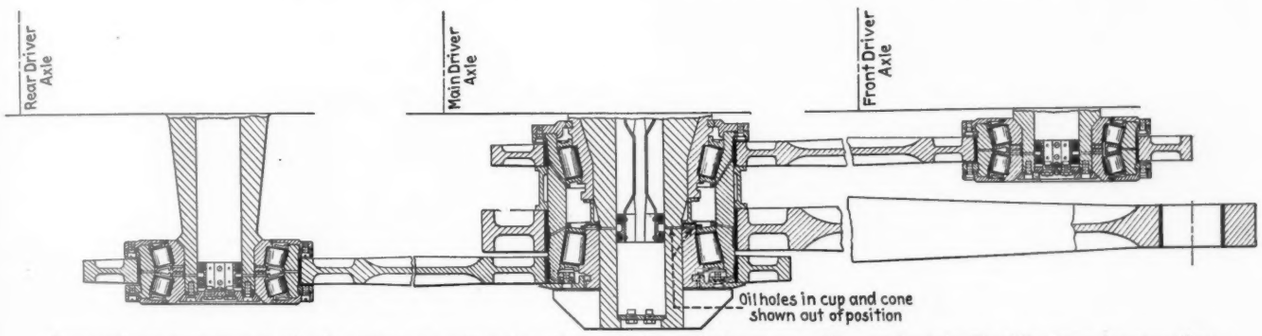
Although differing in detail, all the bearings have the same type closure. This consists of a split retaining ring which, when in place around the cup of the bearing, bears against the inner face of a lateral shoulder or flange on the end of the cup. To this ring is secured, by wire-lock machine screws, the steel closure which moves with the cup. This is sealed by a phosphor-bronze retaining ring set in a groove in the bearing cone and fitting against the inner surface of the end closure. In all cases, except at the outer end of the main crank-pin bearing, the retaining rings fit around the outside of the cups. In the latter case the ring is fitted inside the cup and the closure member, by an extension of its outer diameter, forms the collar to retain the rods in position.

Lubrication

All crank pins are hollow bored, the main to a diameter of 3½ in. and the others to a diameter of 3 in. This bore, closed at the ends, forms a reservoir for lubricating oil and contains the device for metering the oil to the bearing. This consists of a short metal cylinder, in the outer surface of which are grooves for felt rings and between these rings a circular cavity from which two passages 180 deg. apart, drilled through the crank-pin wall, lead to a small annular groove cut in the inner circumference of one of the bearing cones. From this annular passage two drilled holes, 180 deg. apart, but spaced 90 deg. from the holes through the crank pin, conduct the oil into the space about the rollers.

The lubricant used is steam cylinder oil. Holes drilled through the sides of the grooves in the cylinder within the pin bore give the oil access to the felt rings and permit it to feed through these rings into the cavity between them. The amount which feeds through the felt rings is determined by the hydraulic pressure to which they are subjected and this varies with the speed of rotation of the driving wheels. The feeding of the oil is thus automatically proportioned to the speed of the locomotive. As the oil enters the space about the rollers it is thrown to the inside of the cup by centrifugal force, where it accumulates about the rollers and overflows through passages in the cup which lead to the rod bearings. Thus, there are no oil holes in the rods. Rex fittings in the outer ends of the crank pins provide for the filling of the oil cavities inside the pins.

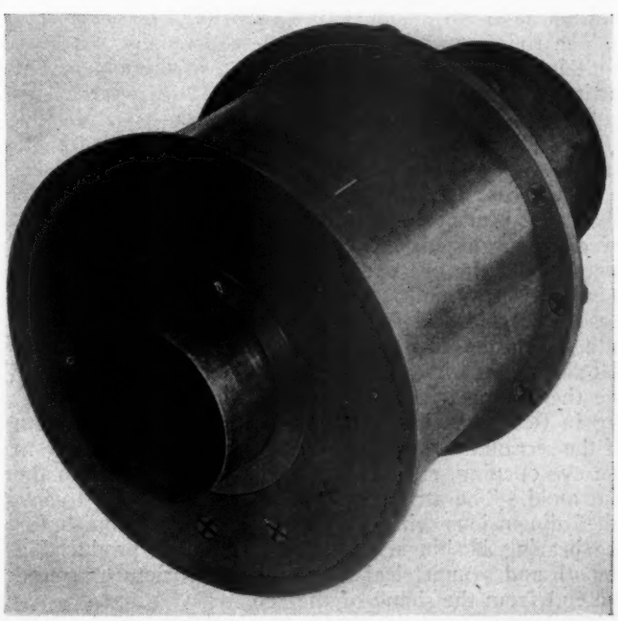
It is thus evident that the roller bearings float between the pins and the rods. In the case of the main pin, the bearing cup itself performs the double function of knuckle pin and crank pin in distributing the load from the main rod to the front and back drivers. The main crank pin itself is only subject to as much of the load as is transmitted to the main wheel. The length of the bearing on this pin has been determined by the necessity for locating the main rod according to present cylinder spacing rather than by the requirements of rod and pin design. Hence, the relatively large spacer between the front section of the side rod and the main rod and the $8^{27}\frac{}{32}$-in. rear crank pin extension by which the bearing is separated from the face of the rear driving wheel.



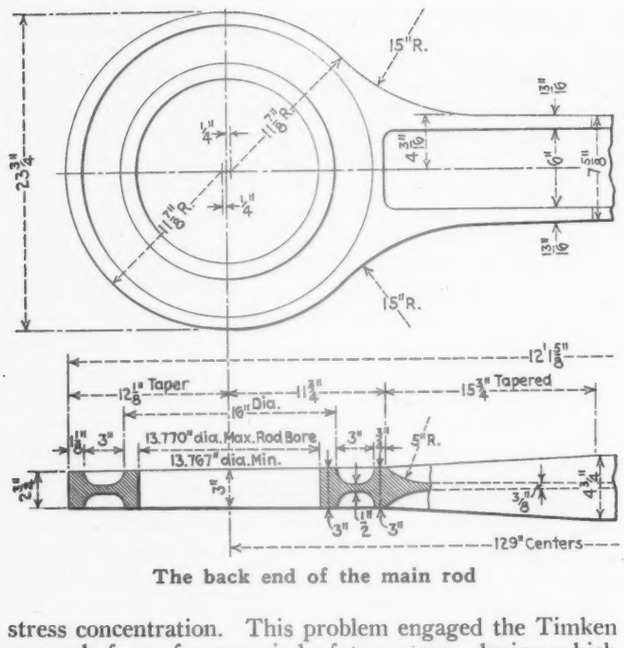
General arrangement of the Timken-roller-bearing-rod installations on a Pennsylvania Pacific type locomotive

The Rod Design

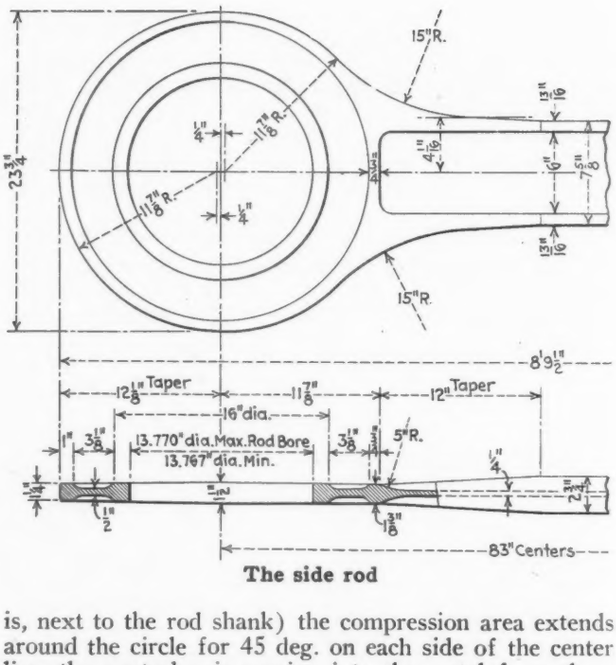
The rod design finally adopted was developed after an extensive study involving a long series of tests to determine the best distribution of metal to avoid high



The Timken roller-bearing assembly on the main crank pin



The back end of the main rod



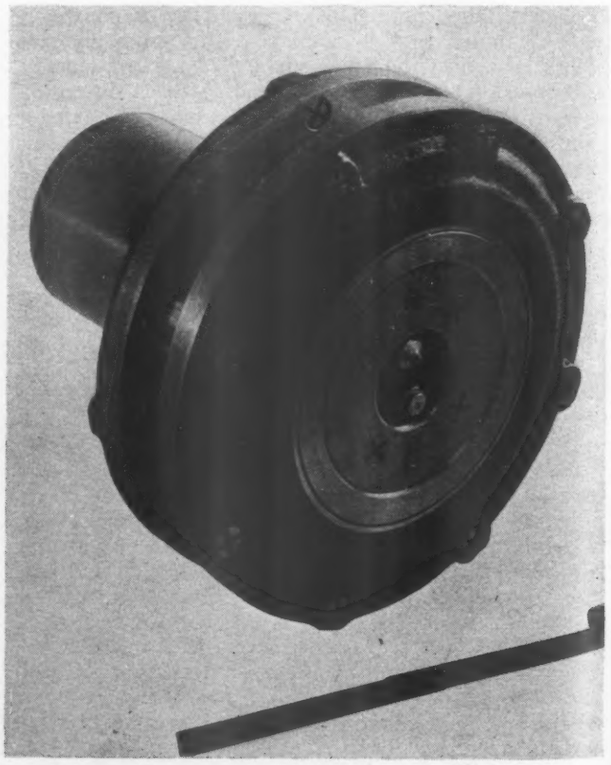
The side rod

stress concentration. This problem engaged the Timken research force for a period of two years, during which strain-gage studies were conducted that involved over 6,000 readings on the rod ends and nearly as many on the column sections. A typical rod-end test involved investigations of the stress distribution radially across the I-section, at every 15 deg. around the outer half of the eye circle, and at 30-deg. intervals around the shank half of the circle. At each of these radial sections seven readings were taken on each side of the rod, of which two each were on the outer and inner flanges, respectively, and three on the web. Additional readings with strain gages set at 45 deg. and 90 deg. from the normal setting were taken on each side of the web at each of the 30-deg. intervals. In developing the curves of stress distribution across each of these various radial sections, from 6 to 14 readings were taken at each strain-gage location. The stresses were taken with a total rod load of 58,000 lb., an amount which would be developed by an adhesion of 30 per cent. The actual design load for normal adhesion amounts to 48,000 lb.

The rod form adopted is of I-section, tapering horizontally to relatively narrow bearings at the ends. The main-rod section is 7⅝ in. deep by 4¾ in. wide. This tapers to a width of 3 in. at the bearing. The side rod, also 7⅝ in. deep, is tapered from a body width of 2¾ in. to 1½ in. at the bearings.

In the case of both the side and main rods the metal about the bearings is formed in I-section by a process of drop forging developed to insure a smooth flow of metal about the eye openings. This process starts with a bar of 7-in. round stock. Each end of this bar is first upset into spherical form. The sphere is then flattened into a pancake and the body of the rod forged into a flat section on a hydraulic press. The rod ends and body are then formed into the finished section by drop forging in two operations. In the first operation the form of the section is essentially completed with all metal from the eye opening, except a thin flash, forced out into the rim mold. The second operation brings the rod to finished dimensions with allowance for machine finish for the bearing bushings. By this method is produced a smooth and symmetrical flow of grain structure around the end from the shank of the rod.

The load tests of the side-rod end adopted disclose the fact that the metal in the bore is under compression at both sides on the center line of the rod. At 0 deg. (that is, next to the rod shank) the compression area extends around the circle for 45 deg. on each side of the center line, the neutral axis passing into the metal from these extreme points to form an ellipse which crosses the center line of the rod at about the middle of the web portion of the I-section. At 180 deg. the compression area extends about 30 deg. each way from the center and penetrates about ¾ in. into the inner flange of the I-section of the center line. Similarly, neutral axes parallel to the center line of the rod, pass through the top and bottom quarters of the rod end, penetrating into the I-section for a depth of about an inch from the outside where they cross the 90-deg. center lines and passing out approximately 30 deg. on either side of this



The roller-bearing assembly on the front and rear crank pins

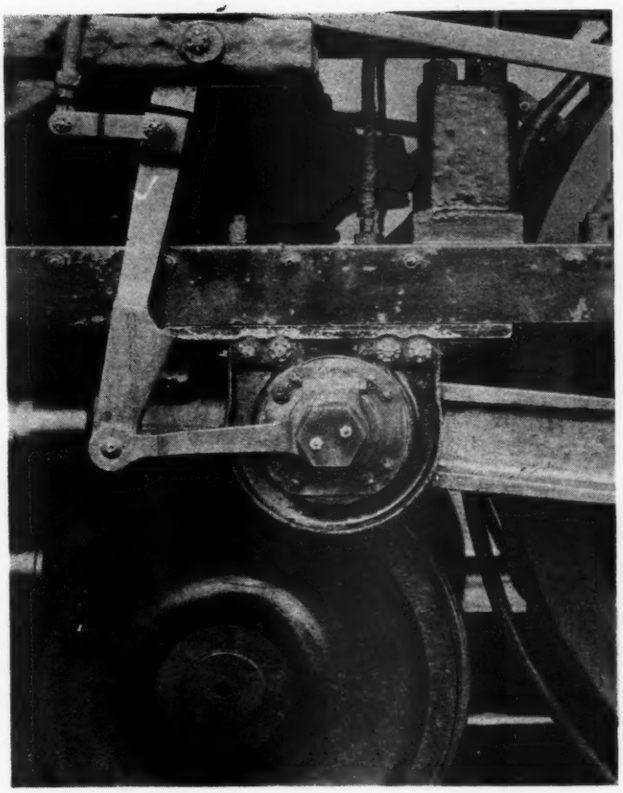
center line. The metal outside of these lines is in compression. Under the 58,000-lb. loading, with normal pin fits ($\frac{1}{64}$ in. loose) in the bore, the compression at 0 deg. amounted to 12,500 lb. per sq. in. and at 180 deg. 2,655 lb. per sq. in. The maximum tension in the bore, at 90 deg., showed 23,500 per sq. in. At 45 deg. the stress is uniformly tension across the section from the bore to the outside, with values varying from 4100 lb. per sq. in. to 6,700 lb. per sq. in. The maximum tension in the outer edge of the section at 180 deg. amounted to 8,900 lb. per sq. in., while the compression at 90 deg. was 6,300 lb. per sq. in.

With maximum wear of $\frac{1}{64}$ in., or a total looseness of $\frac{5}{64}$ in., these values increased in the bore to 18,100 lb. per sq. in. compression at 0 deg. and 26,500 lb. per sq. in. tension at 90 deg., while the tensile stress at the outside of the section increased from 8,900 lb. to 18,900 lb. per sq. in. at 180 deg. These show stress increases varying from nearly one half to two thirds as the result of $\frac{1}{16}$-in. wear. In these tests the stress in the shank of the rod was about 11,500 lb. per sq. in.

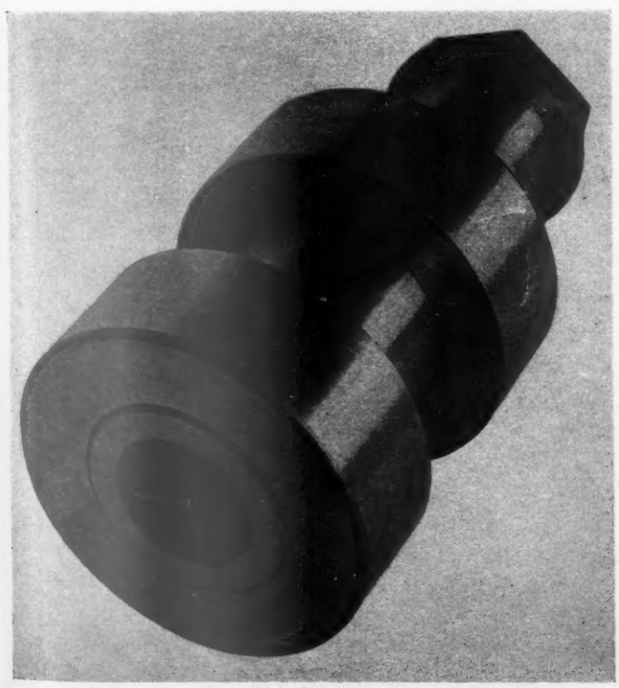
Interesting tests showing the effect on the stresses in the eye of varying the tightness of the crosshead-pin fit in the front end of the main rod were made with a maximum load on the rod of 117,400 lb. With the pin pressed in .004 in. tight the combined stress due to the pressed fit and the load varied from a tension of 9,700 lb. per sq. in. at the outside to a tension of 21,800 lb. per sq. in. on the inside across the 90-deg. section, and from a tension of 6,300 lb. per sq in. to a tension of 20,900 lb. per sq. in. across the section at the end (180 deg.). Pressing in the pin with a fit .0005 in. tight reduced the combined stresses to a range from 8,000 lb. at the outside to 17,800 lb. inside across the 90-deg. section and through a similar range from 3,300 lb. to 7,400 lb. at the 180-deg. section.

Crosshead and Piston

One of the most interesting parts of the installation is the crosshead. This consists essentially of three parts: the body, the pivot plates and the shoe. The body of the crosshead is a forging which serves to connect the piston rod with the wrist pin. Bosses about the wrist-pin opening on the sides of the crosshead serve as bearings for the pivot plates which are free to rotate about them. Between the pivot plates is bolted the aluminum-alloy crosshead shoe designed for the Pennsylvania type multi-wear guide. Thus, neither inertia forces from the crosshead shoe nor piston-head wear can produce bending movements in the piston rod.



The crosshead, on which the shoe is pivoted

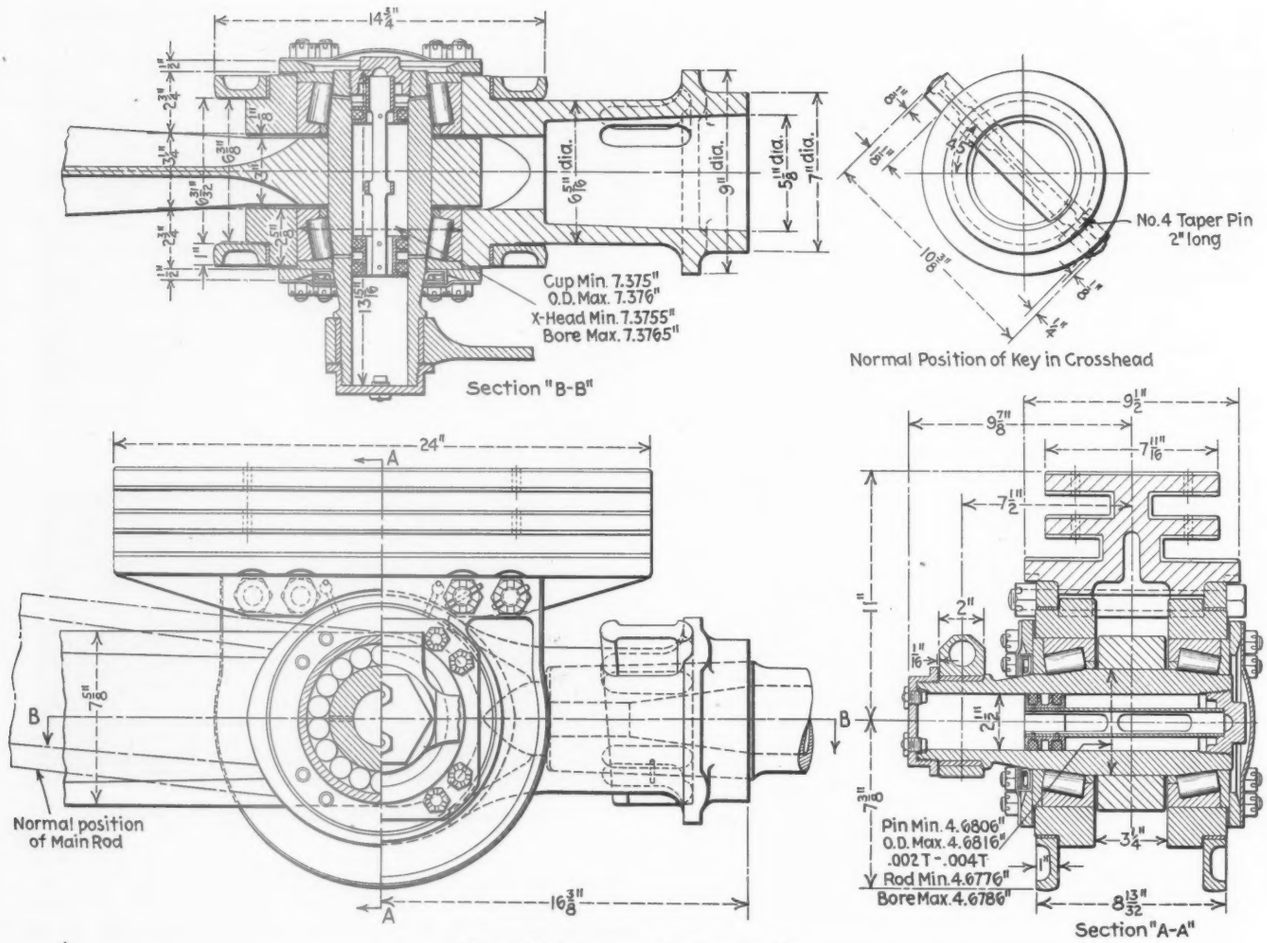


The roller bearings mounted on the crosshead pin

The wrist pin is mounted in two specially designed Timken roller bearings, each consisting of a single set of rollers without retainers in a cone pressed in the crosshead. The inner race of the rollers is the wrist pin itself, which is pressed in the front end of the main rod. Like the crank pin, the wrist pin is hollow bored, to 2½ in. in diameter, and contains lubrication devices similar to those in the crank pin, one for each set of rollers. The inner end of the bearing is completely enclosed by a plate bolted to the crosshead. At the outer end where the end of the pin extends through for the union link , special rawhide seal is provided. The bushings of the pivot plates on the crossheads are $\frac{1}{8}$-in. bronze strips fabricated similarly to those in the rods.

Both the piston and piston rod are forgings. The rod, which is forged from cold-drawn Timken seamless tubing, is 3 in. in inside diameter and 4½ in. in outside diameter. The shape of the piston conforms to the standard for the engine class, except for a substantial reduction in section and weight. Because of the thinner sections and higher strength of the steel the piston deflects within its yield point 2.8 times as much as a carbon-steel piston of axle grade within its yield point. This is the equivalent of two pints more in water entraining capacity per cylinder before rupture of the piston will occur.

Indicative of the care with which the distribution of metal in the various parts has been studied is the crosshead key. At the edges where it bears against the ends



The Timken crosshead assembly

of the keyway in the crosshead and the rod the key is 1⅜ in. wide. The body, however, is forged down to a web thickness of ⅜ in., except where it bears directly against the keyways. Here it is increased to ¾ in. to resist the shear. This key weighs 8½ lb.

Rod and Bearing Weights of Pennsylvania Locomotive No. 5371

Weights on the Crank Pins, Lb.

With Roller-Bearing Rods

	Front	Main	Rear	Total all drivers
Weights fixed on pin	103	330	199	632
Weights revolving on pin	93	255	93	441
Rods	125	610	125	860
Total	321	1,195	417	1,933
With Plain-Bearing Rods				
Crank pins and parts (fixed)	97	282	97	476
Weight on pins (revolving)	188	1,153	204	1,545
Total	285	1,435	301	2,021

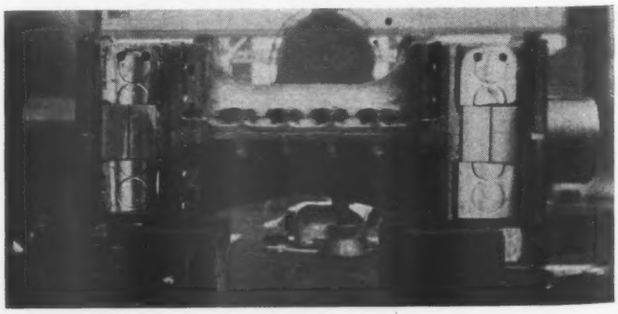
Reciprocating Parts

	Timken design	Plain bearings	Saving over P.R.R.
Total weight crosshead and parts	387	599	212
Piston and details	364	484	120
Main rod, front half	226	401	176
Total	977	1,485	508

The table shows a comparison of the weights on the crank pins and the weights of reciprocating parts of the locomotive with its original rods and after it was equipped with Timken roller-bearing rods. It will be seen that, with the Timken rods, there is a total reduction of weights on all three crank pins of 88 lb., which includes a net reduction of 40 lb. in the weights of the crank pins themselves, a reduction in weight on the main crank pin of 240 lb., and a reduction in the weight of the reciprocating parts of 508 lb. At 100 m.p.h. this effects a reduction in total crank-pin load of approximately 48,500 lb. With an over balance of 170 lb. in each driving wheel, as compared with the 286 lb. originally in each wheel, the Timken-equipped locomotive may be run up to 117 m.p.h. before its dynamic augment reaches the value of that of the locomotive with the plain bearing rods at 90 m.p.h.

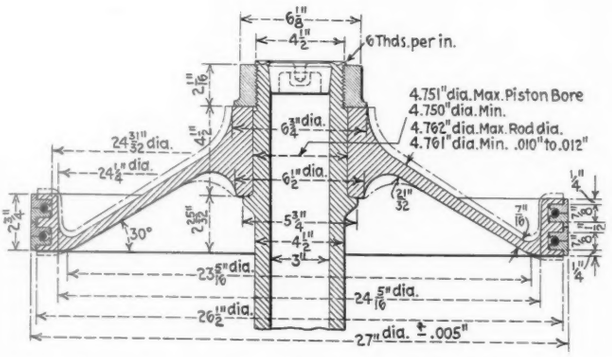
Driving-Box Installation

In preparing the frame pedestals for the Timken driving boxes the tapered sides of the pedestal jaws have



The driving-journal bearing and housing mounted on the axle

been built up by welding, with wedge shaped fillers, and a hard bronze liner installed to provide a bearing face which is parallel to the shoe face of the jaw. This is also faced with a hard bronze liner. Like other Timken driving-axle installations, the bearings on each axle are mounted in a single box unit which, surrounding the axle, extends across the locomotive between the frames. Lateral movement of the axle and box unit is controlled by flanges inside the frame which bear against hardened steel facings welded to the inside of each pedestal leg. The bearing on each journal consists of two sets of



The light-weight piston—The broken lines indicate the contours of the piston head replaced

Timken roller bearings. All axle journals are 10¾ in. in diameter. The pedestals are closed with the usual binders. The boxes are 17½ in. in width over the housing liners, and 1/64 in. total clearance is allowed between these liners and the frame shoes.

The trailer housing is designed to fit the trailer truck without change either in the pedestal or in the springs. The bearing has two sets of rollers pressed onto a journal diameter of 6½ in.

Santa Fe Gets Largest Diesel Locomotive

(*Continued from page 489*)

used. The various lines in this trunk feed contactors which control the different pieces of apparatus in the locomotive. This trunk line operates on battery current. As the high voltage contactors are directly over the generator, this provides a minimum of high current-carrying wire.

Control stations, one in each cab, are equipped with a master controller, reverse lever, throttle lever, brake valves, sander valve, control switches, and instrument panel, so grouped around the operator's seat as to give the greatest ease of operation.

The controller lever has three running positions for controlling the motor grouping to provide the maximum tractive force at all speeds. The controller is also equipped with a reverse lever to regulate the direction of travel. The throttle is equipped with eight running positions in addition to an idle position. Through electro-pneumatic linkage, it operates a Woodward variable-speed engine governor, which in turn controls the engine speed.

The 8-EL brake and sander valves are similar to those used on steam locomotives. Switches for the positive battery control of engine starting, fuel pumps, and exciter field are located on the side of the throttle stand. The various light switches are in a box over the engineman's side window. This gives him complete control of the locomotive at his station.

Each unit is completely equipped with instruments to check the operation of the various pieces of apparatus. At each control station there is an instrument panel upon which are located the two air gages, speedometer, and warning lights for low oil supply. On each of the main engines there is an instrument panel containing a tachometer, water thermometer, and fuel- and lubricating-oil pressure gages. The auxiliary engine also has a water thermometer and pressure gages for fuel and lubricating oil. Each engine has connections for an exhaust pyrometer for measuring the temperature of the exhaust gases from each cylinder. The heating boiler has steam-pressure and water-temperature gages.

Double-end continuous train control apparatus, furnished by the Union Switch & Signal Company, has the usual cab signals and is arranged not only to stop the train by means of brake application but to cut off the power from the engine in the event of a penalty stop.

The battery is an Exide 450-amp.-hr. unit, consisting of 32 cells. This battery supplies electric current for engine starting, control operation, and all auxiliaries, such as fuel pump, boiler motors and locomotive lights.

The locomotive is well equipped with warning signals. A standard 14-in. bell with automatic ringer is mounted on the roof, and at each end of the locomotive there is a Typhon air horn. These horns give loud penetrating blasts and are used in place of the steam whistle. An electric siren is provided to give still further warning in cases of emergency. The locomotive is equipped with standard air signal equipment.

Record of Test Run

The 3,600-hp. Santa Fe Diesel-electric locomotive just described recently made a record run from Los Angeles, Calif., to Chicago, Ill., hauling a special nine-car train of conventional heavy steel passenger cars weighing over 720 tons. The train completed this run of 2,228 miles in a total elapsed time of 39 hr. 34 min., including 11 scheduled stops. This constitutes a record long-distance run for any train of standard steel equipment. Over 15 hr. was cut from the time of the Santa Fe's "Chief," the fastest regular train between Los Angeles and Chicago, while 5 hr. 20 min. was cut from the record of 44 hr. 54 min. made between the same points by Death Valley Scotty's famous special train in 1905, a record which has stood unchallenged for nearly 30 years.

PLOVER LIKES THE RAILROAD.—In spite of the fact that switch engines and freight cars passed over the spot several times a day, a golden plover laid four eggs in a nest that she made between the rails of an Illinois Central track in Dubuque, Iowa. The eggs were discovered by James Nichols, car inspector. Having found birds' nests in box cars, on brake beams, on tank cars, on deserted engines and many other freak places in the 25 years of his railway service, Mr. Nichols suspected a nest when he saw the plover dancing along one of the rails and scolding at his approach. He found the eggs right in the center of the track in a depression in the cinders. For several days, the plover's mate stayed close at hand, but finally the noise and activity of the busy railroad became too much for him and he disappeared. The mother stuck to her eggs, however, bouncing out of the nest and running alongside and spreading her yellow fan tail in protest when the switch engine and cars came along. The baby plovers, when they arrive, probably will be streamlined in accordance with the latest ideas in railroading.

Air Resistance Of Passenger Trains

By
George W. DeBell* and A. Lipetz†

Analytical Laboratory Research and Mathematical Determination of Air Resistance of Railroad Passenger Trains. A Study conducted jointly by the American Locomotive Company, the American Car and Foundry Company and the J. G. Brill Company in the New York University wind tunnel

DURING the summer of 1934, the American Locomotive Company, the American Car and Foundry Company and the J. G. Brill Company, conducted an extensive program of wind-tunnel tests on railroad trains in the wind tunnel at New York University, under the supervision of Professor Alexander Klemin. This wind-tunnel program consisted primarily of two parts: a preliminary program to determine the best method of

NEW YORK UNIVERSITY SCHEDULE OF TRAIN MODEL WIND TUNNEL TESTS - NO. 717

Scale of Model	1/32 Size 3/8" = 1'												1/16 Size 3/16" = 1'																				1/32 Size 3/8" = 1'						
Test No.	1	1A	2	3	4	5	6	7	8	9	10	11	12	16	17	18	18A	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37					
Standard Locomotive																											X	X	X	X	X	X	X							
Streamline Locomotive													X	X					X	X	X	X	X	X	X								X						
Power Car	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X																				
Tail Car	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X						
No. of Standard Coaches																														1	2	3		1	2	3				
No. of Streamline Coaches	2	2	2	2	2	2	1		3	4		1	2		2	2	1																						
Open Side Sill Skirts	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X						
Closed Side Sill Skirts						X																																	
Power Car - Standard Trucks			X																																			
Power Car - Faired Trucks	X	X		o	o	o	o	o	o	o	o	o	o			o	o	o	o																				
Trailing Cars - Standard Trucks	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X								X						
Trailing Cars - Faired Trucks		X																																					
Diaphragms - Smooth	X	X	X	X	X	X	X	X	X	X	X	X	X			X		o	o	o	o	o	o	o	o								o						
Diaphragms - Cowled																	X																						
Tail Fairing Long C.T. No. 2	X	X	X		o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o								o						
Tail Fairing Short C.T. No. 1				X																																			
Power Car Nose No. 1					X																																		
Power Car Nose No. 2	X	X	X	X		o	o	o	o	o	o	o	o			o	o	o	o																				
Helmet Nose													X	X					X			o	o	o	o								o						
Round Nose																				X																			
Straight Nose																					X																		
Round Top													X	X					X	X	X		X	X	o								o						
Cowled Top													X	X								X											o						
Closed Shroud (Loco. and Tender)													X	X					X	X	X		o		o								o						
Open Shroud (Loco. and Tender)																						X																	
Short Shroud (Loco. and Tender)																							X																
Smoke Test													X	X																										
Velocity Run Included (0° Yaw)	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
Yaw Test (0° to Max. Angle)	X		X	X	X	X	X	X	X	X	X	X	X																						X	X	X	X			
Drag Test																																								
Test Tail Car - Presence of Train												X	X	X																										

Note:- X = Types Tested o = Best Type

Fig. 1

representing ground effect, and a main test program to determine the actual drag of various models and consists.

The preliminary program was carried out on a simplified train model representing a streamlined locomotive and tail car. This model was tested (1) in free air, (2) by the mirror method, (3) adjacent to a fixed ground board with varying heights of model from ground board and (4) by the running-belt method in which the model was suspended in proper relation immediately above the running belt. In the running-belt test the model drag was measured both with the belt running and with the belt stopped. A comparison of the drags so obtained indicated that the small differences between the belt running and the belt stopped were well within the limits of accuracy of measurement.

The running-belt test, with the belt moving at the same velocity as the air, truly represents the relative velocities of the train, air, and ground, in actual practice, and since the differences in drag between belt run-

* Aeronautical engineer, American Car and Foundry Company.
† Consulting engineer, American Locomotive Company.

Fig. 2—Streamlined power-car train model set up for yaw testing

ning and belt stopped were negligible, a stationary belt, in other words a fixed ground board, can be used for determining the air drag of model trains without any appreciable error.

The remaining tests of this preliminary program may be summarized by the following two statements: The further a model is raised from a fixed ground board the higher the model drag; the air forces by the mirror method do not follow the same aerodynamic laws as the air forces by the other methods.

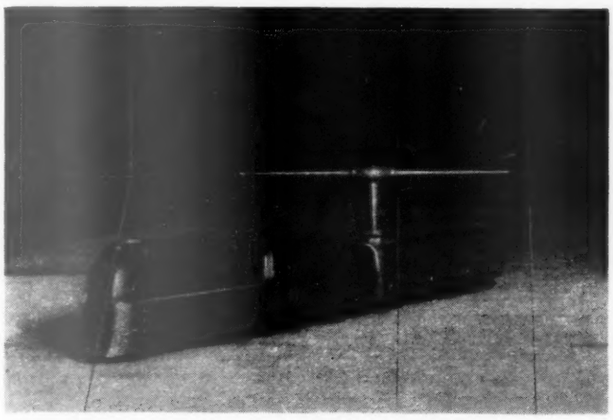


Fig. 3—Streamlined steam locomotive and tail car model set in the wind tunnel for yaw testing

The main test program, which consisted of a series of 35 tests, was carried out on models representing streamlined power-car trains, streamlined locomotive trains, and standard unstreamlined trains. The models of both the streamlined power-car trains and the streamlined locomotive trains were designed to permit the testing of several contour variations. The standard trains consisted of New York Central 4-6-4 Hudson type locomotives and tenders and New York Central coaches but, of course, there were no contour variations. The models were built to two different scales, namely 1/32 and 1/16 of full size. The large 1/16 scale models were used in order to reduce the scale effect when expanding from model size to full size and also more easily to represent the actual trains in full detail. The 1/32 scale models were used for the quartering-wind tests (yaw tests) as the width of the tunnel would not permit a larger model to be used and still obtain air force measurements at fairly large angles between wind direction and the train.

The Main Test Program

Fig. 1 shows the wind-tunnel test schedule for the main test program and shows the consist, size, and type of the models as well as the type of tests to which the models were subjected. Fig. 2 is a photograph of the 1/32 scale four-car power-car train as set up in the wind tunnel for a yaw test. Fig. 3 is a photograph of the 1/32 scale streamlined locomotive and tail-car model as set up in the wind-tunnel for a similar test.

The power-car train models were tested with the following contour variations:

1—Blunt versus well streamlined nose, Fig. 4.
2—Long versus short tail fairing, Fig. 5.
3—Standard versus faired trucks on the power car, Fig. 6.
4—Standard versus faired trucks on the trailing cars, Fig. 7.
5—Smooth versus cowled diaphragms, Fig. 8.

In addition these trains were also tested with closed versus open skirts, Fig. 9, and with the number of intermediate coaches varying from zero to four.

All the above contour variations were tested on the 1/32 scale power-car model, with the exception of the cowled diaphragm test, which was made on the 1/16 scale model. The power-car models represented a full-scale power car having a length of 73 ft., while the tail-car model represented a full-scale tail car having a length of 70 ft. The models of intermediate coaches represented full-scale coaches of a length of 67 ft. each between coupler pulling faces. All the above cars had a full-scale width over posts of 9.875 ft. and an overall height from top of rail of 11.125 ft. The models represented full-scale cars in which the depth of the window

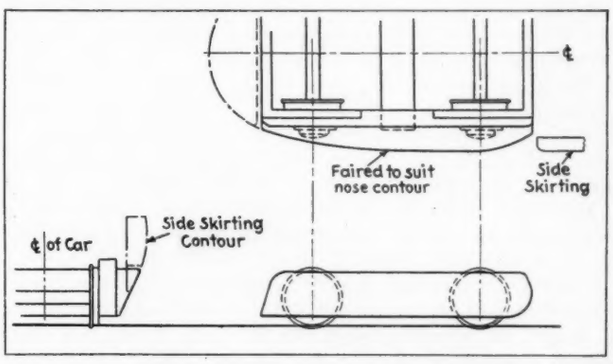
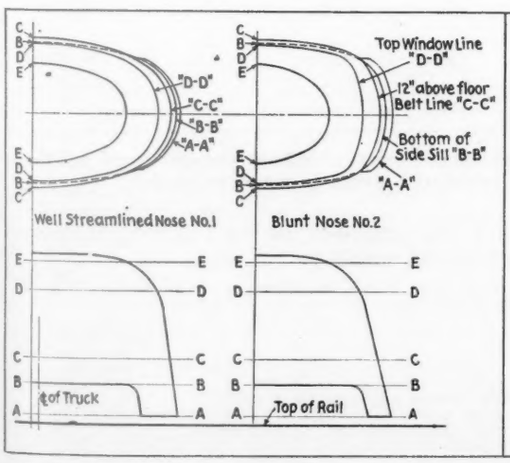


Fig. 6—The lead truck fairings on the power car



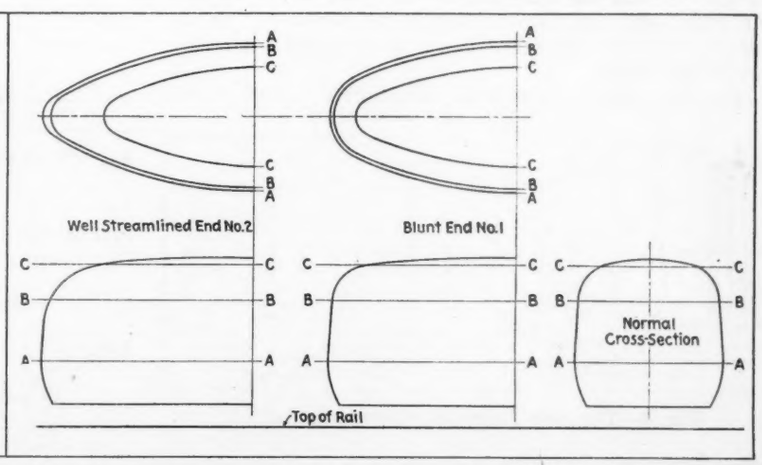


Fig. 4 (left)—The form of power-car nose fairings tested; Fig. 5 (right)—The streamlined tail fairings tested

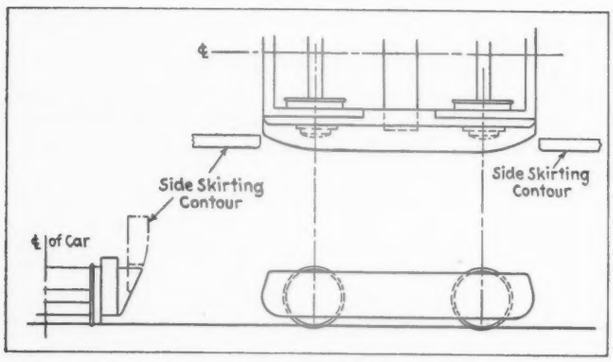


Fig. 7—The fairings on the rear truck of the power car and on both trucks of trailer cars

set-backs was ¼ in. and the set-back of the doors was not more than ⅛ in. The ventilators and underframe equipment of these cars was so designed as to offer as little air resistance as possible. Only the two saloon ventilators were represented, and these were of streamlined design. Ventilation for the rest of the car was assumed to be handled by the air-conditioning system. The underframe equipment, which was fully represented on the models, was so designed and arranged as to be shrouded by the open or closed skirts. The cars were of the non-articulated type and the trucks were fully represented on the models. With the exception of the window and door set-backs and streamlined ventilators, the exterior of the models was perfectly smooth, all moulding, etc., being omitted from the design.

The 1/16 scale streamlined - locomotive model was tested with the following contour variations: three types of wheel shrouds, Fig. 10; three nose shapes, Fig. 11; two boiler shapes, Fig. 12. It represented a streamlined locomotive and tender of the 4-6-4 type having an overall length of approximately 94 ft. Fig. 13 shows the general contour of this locomotive and tender. The tail car which was tested in conjunction with the streamlined locomotive was the same car as that used on the power-car train, and the contour variations pertaining to the tail car are given above in the contour variations of the power-car trains.

The 1/32 scale streamlined locomotive model represented a 4-4-4 type locomotive and tender having a full-scale overall length of approximately 78 ft. This model, although so designed as to permit the same contour variations as the large-scale model, was actually only tested in the optimum drag condition; that is, with closed shrouds, a helmet nose, and a round-topped boiler. This combination had previously been tested on the 1/16 scale streamlined locomotive model and had been found to give the least drag. The tail car used with this small-scale locomotive was the same as that used with the small-scale power-car trains.

The models of the standard unstreamlined trains represented a New York Central Hudson type locomotive and tender having a full-scale length of 96 ft. and New York Central main-line coaches having a full-scale length over coupler pulling faces of 78 ft., a full-scale width over posts of 10 ft., and a full-scale height from top of rail of 14.15 ft. Since the contours of the standard trains are well known, it is not necessary to go into a detailed explanation or to show sketches.

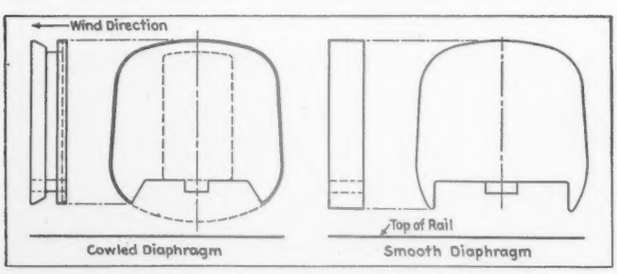


Fig. 8—The two forms of diaphragms tested

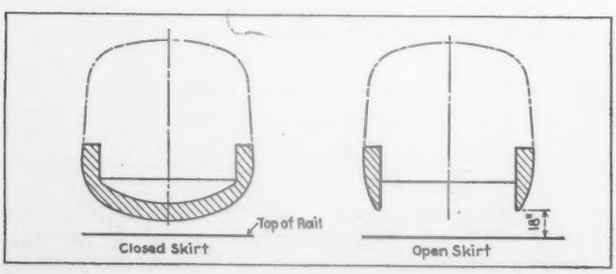


Fig. 9—The form of the open and closed skirts

Application of Wind-Tunnel Results

While the main test program was being run in the wind tunnel, an investigation of the various methods of scale expansion was made in order to determine the best and most reliable method of converting the model test results to full-scale values. From the results of this

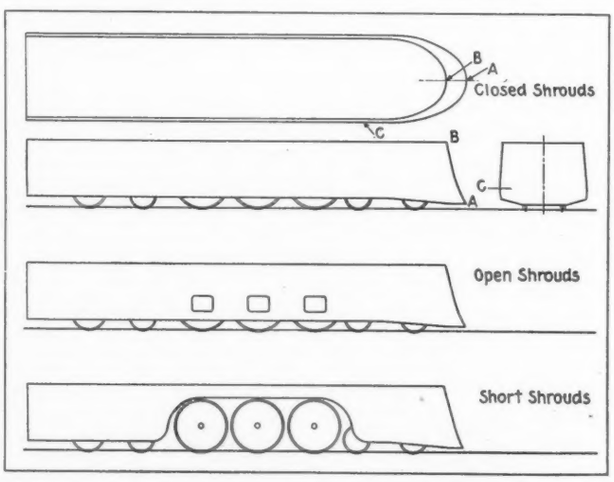


Fig. 10—The three forms of wheel shrouds used on the streamlined steam locomotive model

investigation it was decided to use the following formula to expand the model results to full scale:

$$\text{Full-scale air drag} = Df \times \frac{V^{1.85}}{Vt^{1.85} \times S^{1.85}} + Dp \times \frac{V^2}{Vt^2 \times S^2}$$

Where:

V = Full-scale train speed in m.p.h.
V_t = Wind-tunnel test speed in m.p.h.
S = Model scale (1/32 or 1/16).
Df = Theoretical skin-friction drag of model.
Dp = Pressure drag of model = Total drag of model − Df.

The above formula may be somewhat simplified for full-scale application by including the known values of *Df, Dp, Vt* and *S* in the coefficients, as follows:

$$\text{Full-scale air drag} = Kf \times V^{1.85} + Kp\ V^2$$

Where:

V = Full-scale train speed in m.p.h.
Kf = Theoretical skin friction coefficient at full scale.
Kp = Pressure coefficient at full scale.

But this formula is still somewhat too complex for use in full-scale performance estimating, particularly since the values of both *Kf* and *Kp* vary not only with

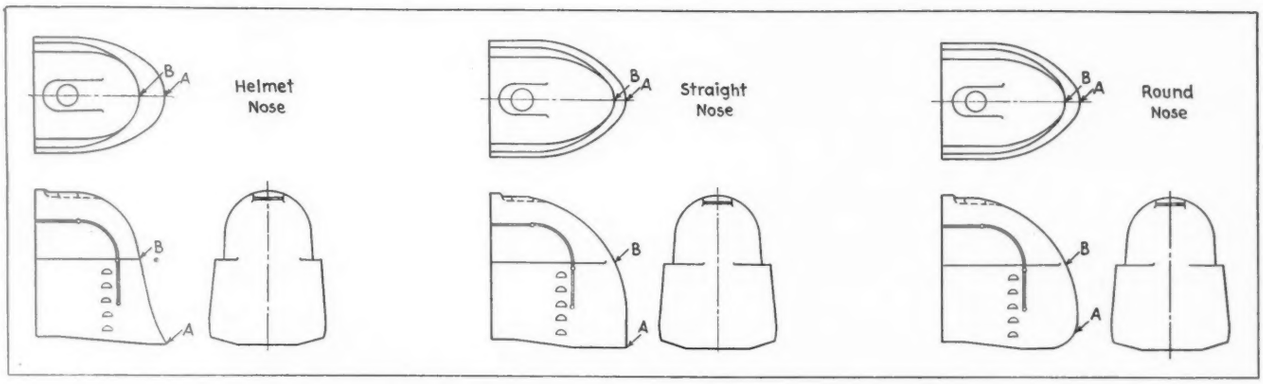


Fig. 11—Nose details of the streamlined steam locomotive model

the length of the train but also with the contour variations and size of car. However, it can be closely approximated by a formula of the following simplified type:

$$\text{Full-scale air drag} = Ct \times V^2$$

Where:

V = The train speed in m.p.h.
Ct = A coefficient which is dependent upon the length of the train, the contour variations, and the size of the cars.

At speeds above 50 miles per hour, where air drag is important, we found that the values obtained from this simplified formula were within 1% of the values obtained from the more complex equation and that at speeds below 50 miles per hour the error was not more than 3%.

In order to present the simplified formula in a form in which the effects of train length, car size, and contour variations can be readily determined, we have broken down the values of Ct into their component parts, and the following is a list of the resulting formulas. It should be noted here that these formulas apply only to trains operating in still air. The effect of ground, or natural winds, will be discussed later in this article.

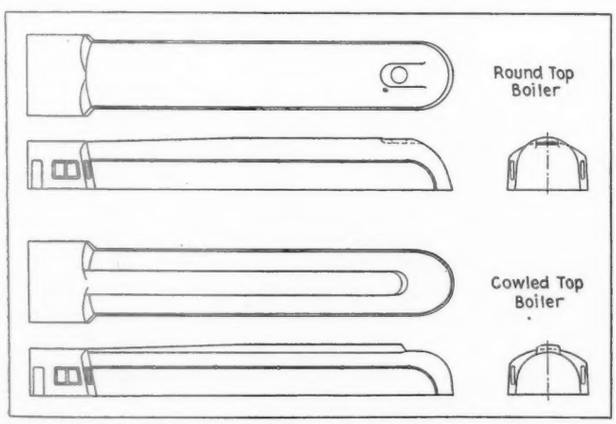


Fig. 12—The two forms of boiler shrouding tested

Simplified Air Resistance Formulas for Trains Operating in Still Air

Power-Car Trains in Still Air

With open skirts (18 in. from skirt to top of rail), Fig. 9.

$$\text{Air drag} = .00224 \times Pc \times \left[\frac{L}{100}\right]^{.8} \times V^2 + \Sigma K \times V^2$$

(See Fig. 14.)

With closed skirts (completely under car), Fig. 9.

$$\text{Air drag} = .0020 \times Pc \times \left[\frac{L}{100}\right]^{.8} \times V^2 + \Sigma K \times V^2$$

(See Fig. 14.)

Where:

Pc = Perimeter of car, in feet, from plane of top of rails over car to plane of top of rails.
L = Overall length of train, in feet.
V = Speed of train in m.p.h.
ΣK = Summation of factors ($K_1 + K_2$ + etc.) of the various items whose drag depends on other dimensions than perimeter and length:
K_1 = Factor for power-car nose shape (Fig. 4)
For nose bluntly streamlined
$K_1 = +.000036 \times$ cross-sectional area of nose at full section, including trucks, in sq. ft.
For nose well streamlined
$K_1 = 0$
K_2 = Factor for tail shape (Fig. 5)
For tail bluntly streamlined
$K_2 = +.000061 \times$ cross-sectional area of tail at full section, including trucks, in sq. ft.
For tail well streamlined
$K_2 = 0$

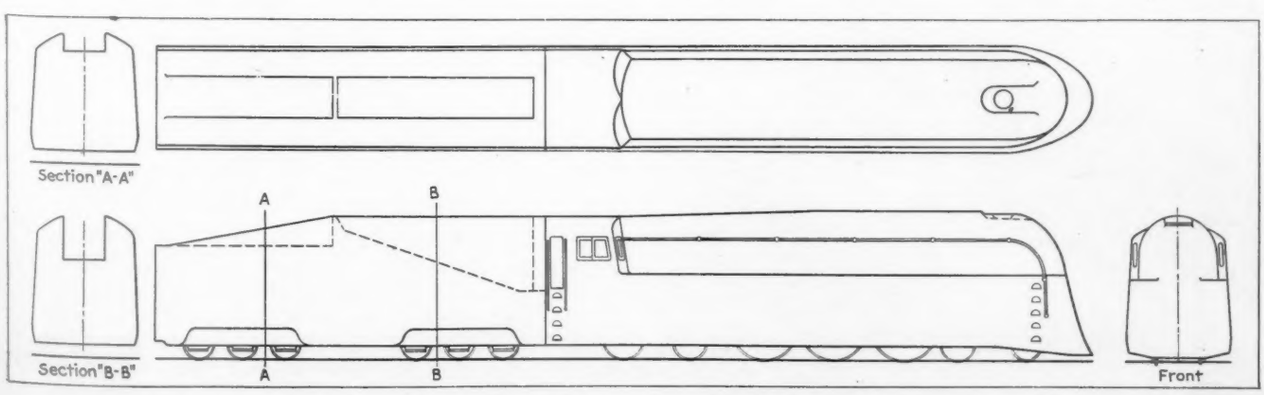


Fig. 13—General view of the combined engine and tender model

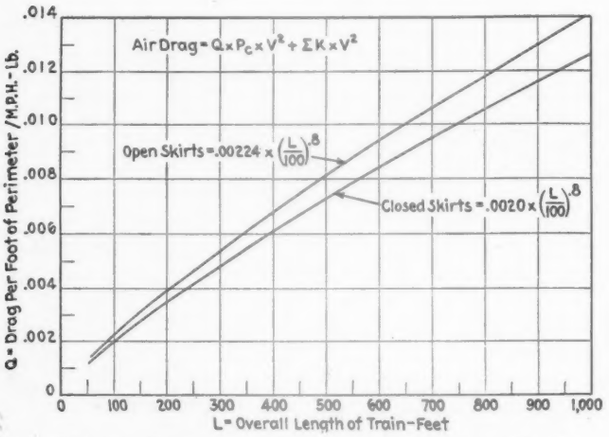

Air Drag = Q × Pc × V² + ΣK × V²
Open Skirts = .00224 × (L/100)^.8
Closed Skirts = .0020 × (L/100)^.8
Q = Drag Per Foot of Perimeter / M.P.H.-Lb.
L = Overall Length of Train-Feet

Fig. 14—Drag factor curves for the streamlined power car trains

K_3 = Factor for power-car trucks (Figs. 6 and 7)
For two faired trucks
$K_3 = 0$
For two unfaired trucks
$K_3 = +.0099$ *

K_4 = Factor for fairing trailing-car trucks on streamlined trains† (Fig. 7)
For faired trucks
$K_4 = -.00013 \times$ number of trailing-car trucks
For unfaired trucks
$K_4 = 0$

K_5 = Factor for diaphragm shape (Fig. 8)
For smooth diaphragms
$K_5 = 0$
For cowled diaphragms
$K_5 = +.000037 \times P_C \times$ number of diaphragms

K_6 = Factor for bulge of power car
For no bulge (as tested)
$K_6 = 0$
For a bulge of good streamline shape
$K_6 = +.00032 \times$ cross-sectional area of bulge in sq. ft. ‡
For a bulge of relatively poor streamline shape
$K_6 = +.00051 \times$ cross-sectional area of bulge in sq. ft. §

* This factor is large because, as tested, the truck fairings formed part of the nose and skirt fairing, and when the truck fairings were removed the nose and skirt shape was damaged. On designs in which the truck fairings do not interfere with the nose or skirt contours $K_3 = +.00026$.

† As tested, neither the trucks nor the fairings interfered with the continuity of the open skirts.

‡ In order for this coefficient to apply, the bulge must be of such a character that it has a streamline shape as good as, or better than, the power car itself. Under this heading may be classed bulges that are merely expansions of the general power car contours, as well as local bulges having well streamlined noses and tails.

§ This coefficient applies where the bulge has a relatively poor shape, such as sharp edges or corners, a blunt tail, a blunt nose, etc.

Streamline Locomotive Trains in Still Air

With open skirts on cars (18 in. from skirt to top of rail), Fig. 9.

$$\text{Air drag} = \left[.023 \times L_L^{1/3} + \Sigma K_L + .001735 \times P_C \times \left(\frac{L_C}{100} \right)^{.88} + \Sigma K_C \right] \times V^2$$

(See Fig. 15.)

With closed skirts on cars (completely under cars), Fig. 9.

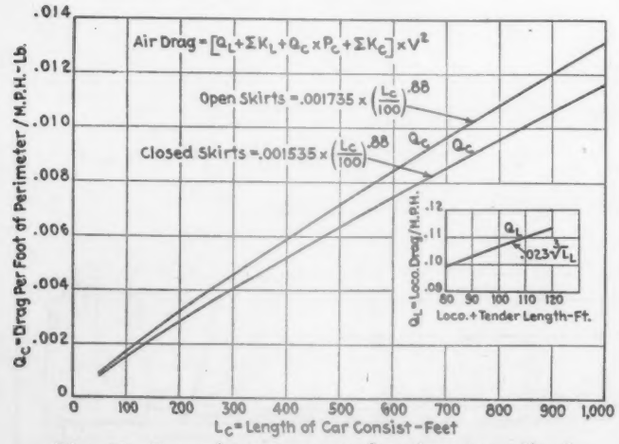

Air Drag = [QL + ΣKL + QC × PC + ΣKC] × V²
Open Skirts = .001735 × (LC/100)^.88
Closed Skirts = .001535 × (LC/100)^.88
QC
QC
QL = Loco. Drag/M.P.H.
QL
.023 × ∛LL
Loco. + Tender Length-Ft.
QC = Drag Per Foot of Perimeter / M.P.H.-Lb.
LC = Length of Car Consist-Feet

Fig. 15—Drag factor curves for the streamlined locomotive trains

$$\text{Air drag} = \left[.023 \times L_L^{1/3} + \Sigma K_L + .001535 \times P_C \times \left(\frac{L_C}{100} \right)^{.88} + \Sigma K_C \right] \times V^2$$

(See Fig. 15.)

Where:

V = Train speed in m.p.h.
L_L = Length of locomotive and tender, in feet.
L_C = Length of car consist, in feet, rear of tender to rear of train.
P_C = Perimeter of cars, in feet, from plane of top of rails over car to plane of top of rails.
ΣK_L = Summation of factors of the various items affecting the locomotive and tender, whose drag depends on other dimensions than those given above:

K_7 = Factor for wheel shrouds on streamline locomotives (Fig. 10)
For closed shrouds (all wheels completely enclosed)
$K_7 = 0$
For open shrouds, Fig. 10 (2 ft. x 2 ft. 6 in. inspection openings over the driving-wheel journals)
$K_7 = +.0005 \times$ total number of openings
For short shrouds, Fig. 10 (driving wheels and tender trucks completely exposed)
$K_7 = +.0182$

K_8 = Factor for nose shape on streamline locomotive (Fig. 11)
For helmet nose
$K_8 = 0$
For straight nose
$K_8 = +.0021$
For round nose
$K_8 = +.0026$

K_9 = Factor for boiler shape on streamline locomotive (Fig. 12)
For round top
$K_9 = 0$
For cowled top (domes and fittings enclosed in longitudinal cowl above boiler shroud)
$K_9 = +.0035$

ΣK_C = Summation of factors of the various items affecting the cars, whose drag depends on other dimensions than those given above. These factors are K_2, the factor for tail shape; K_4, the factor for fairing trailing-car trucks on streamlined trains, and K_5, the factor for diaphragm shape. Their values are the same as given under the formulas for power-car trains.

The first two terms in the brackets of the drag equations for streamlined locomotive trains are functions of the locomotive and tender only, while the last two terms are functions of the car consist only.

Standard Locomotive Trains, N. Y. C. Type, in Still Air

$$\text{Air drag} = \left[.083 \times L_L^{1/4} + .0031 \times P_C \times \left(\frac{L_C}{100} \right)^{.7} \right] \times V^2$$

(See Fig. 16.)

Where:

V = Train speed in m.p.h.
L_L = Length of locomotive and tender, in feet.
L_C = Length of car consist, in feet, rear of tender to rear of train.
P_C = Perimeter of cars, in feet, from plane of top of rails over car to plane of top of rails.

The first term in the brackets of this formula is a function of the locomotive and tender only, while the second term is a function of the car consist only.

The above equations were based on our tests which were carried out on streamlined trains of from two to six cars, giving an equivalent full-scale length of from

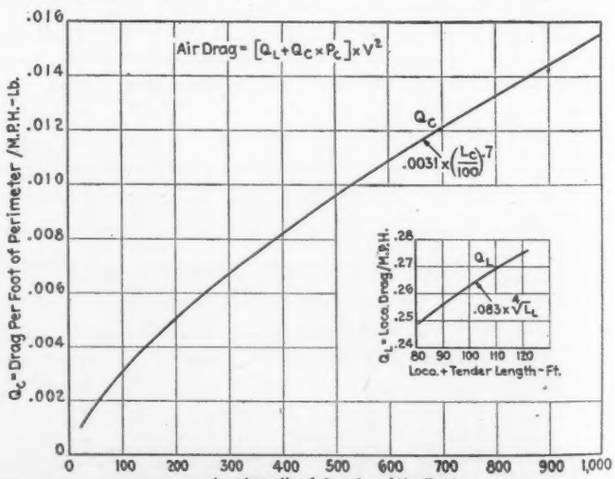

Air Drag = [QL + QC × PC] × V²
QC
.0031 × (LC/100)^.7
QL
.083 × ∛LL
QL = Loco. Drag/M.P.H.
Loco. + Tender Length-Ft.
QC = Drag Per Foot of Perimeter / M.P.H.-Lb.
LC = Length of Car Consist-Feet

Fig. 16—Drag factor curves for the streamlined locomotive trains

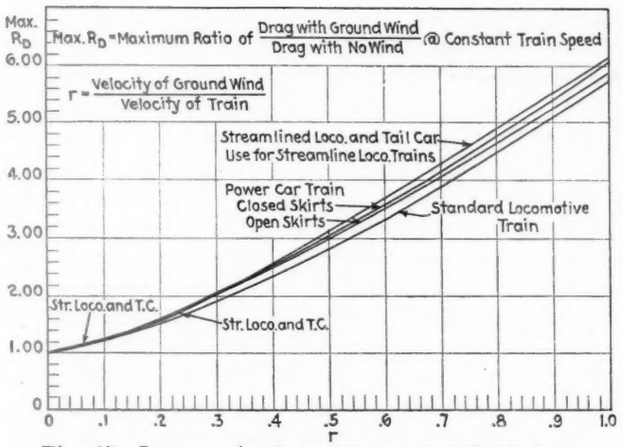

Max. R_D
Max. R_D = Maximum Ratio of Drag with Ground Wind / Drag with No Wind @ Constant Train Speed
r = Velocity of Ground Wind / Velocity of Train
6.00
5.00
4.00
3.00
2.00
1.00
0
Streamlined Loco. and Tail Car Use for Streamline Loco. Trains
Power Car Train
Closed Skirts
Open Skirts
Standard Locomotive Train
Str. Loco. and T.C.
Str. Loco. and T.C.
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1.0
r

Fig. 17—Increase in drag due to ground winds at constant train speed

143 ft. to 411 ft., and on standard trains having equivalent full-scale lengths of from 96 ft. to 330 ft. Although the above lengths give the limits to which the tests were actually carried, it is our belief that the equations may be used for trains of lengths of from 100 to 800 ft. without appreciable error, and that in extreme cases the equations may be used on trains of from 50 to 1,500 ft. without the errors becoming large. This belief is based on the fact that the test points plotted as very smooth curves, which indicates that considerable extrapolation may be made without appreciable error. However, such extrapolation should only be made in cases where more accurate test information is not available.

Effect of Ground or Natural Winds

In actual operation we are interested in determining the increase in air drag, at constant train speed, due to ground or natural winds. For a given train speed the increase in drag is dependent on both the magnitude and direction of the ground or natural wind, but in the majority of cases the exact magnitude and direction of such winds are unknown. However, some allowance for average wind conditions should be made if a high value of on-time performance is to be maintained. At the present time, for want of more accurate information, we suggest that the year-round *average* wind velocity for the particular locality of the run be used and that the wind be assumed always to come from the worst direction. Then, for a given train speed, the drag with a ground wind may be obtained by computing the ratio of the ground-wind velocity Vg to train speed V, obtaining the corresponding value of R_D, from Fig. 17, and multiplying the still-air drag at the given train speed by the factor R_D. In other words, at a given train speed V:

$$\text{Air drag with a ground wind} = R_D \times D_O$$

Where:

R_D = The multiplication factor as obtained from Fig. 17 for the correct value of $\frac{Vg}{V}$.

D_O = Drag of the train in still air at speed V.

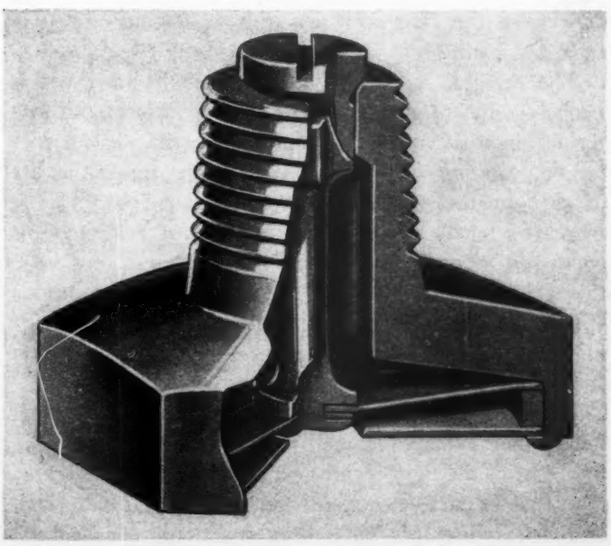
After we have had more experience in the operation of streamlined trains we will undoubtedly be able to arrive at a closer approximation of the actual average ground wind than we are at the present time, but in order to make some allowance, at present, for effect of ground winds, we must rely on information obtained from the government weather bureau, from which we can obtain the year round average winds. Later we may find that we should apply a correction factor to these average ground winds in order to obtain an accurate working value for performance estimation, but, as we have previously mentioned, the derivation of this factor will depend upon the data obtained from actual operation of streamlined equipment. The importance of taking account of ground winds may be seen from Fig. 17, which shows that a ground wind of one-third of the train speed may more than double the air drag of the train and that a ground wind of one-fifth of the train speed may increase the air drag by more than 50 per cent.

Springless Automatic Drain Valve

THE illustration shows a springless automatic drain valve recently developed and placed on the market by the Wilson Engineering Corporation, Chicago. It is designed for use at the low point in any exhaust steam line, pipe or passage, which must be drained of condensate to prevent freezing when not in use. The particular feature of the device is the provision of a drain valve operated by temperature change rather than by pressure as used in the conventional spring-type automatic drain valve. By this construction a sensitive valve control is obtained which is said to operate reliably at pressures too low to close the spring-type valve.

In the design of this new valve a Spencer bi-metallic disc is used to motivate the valve, thus the valve will remain closed against the escape of steam vapor regardless of pressure and as long as the requisite temperature is maintained. When the temperature falls below the critical setting, the valve opens against low pressures.

In service, the benefits of a thermostatically-controlled valve become at once apparent. Located in exhaust passages or in exhaust steam lines, there will be no obscuring of vision due to a slightly leaking throttle. When the temperature falls below 150 deg. F. the valve opens, drains out the cooled condensate and immediately closes if steam or hot water follows. In locations where carbonized oil might cause a spring-type valve to become locked in a closed or open position, this new valve is said to be self-clearing.



Wilson springless automatic valve for draining locomotive steam pipe lines

EDITORIALS

You Will Want This Index

The pages of the 1935 issues of the *Railway Mechanical Engineer* are replete with detailed descriptions of many innovations in equipment design—the "Flying Yankee" for the Boston & Maine; the "Comet" for the New York, New Haven & Hartford; the "Rebel" for the Gulf, Mobile & Northern; the new high-speed locomotives and cars for the Baltimore & Ohio and the Chicago, Milwaukee, St. Paul & Pacific, etc. An index to these features alone should prove invaluable for future reference. Obtain your copy of the 1935 index by sending us your name and address promptly if you are not already on our mailing list through the receipt of that for 1934.

Alloy Steels In Car Construction

The reductions in weight of freight cars which have been effected by the use of the so-called intermediate steels have directed attention to the possibilities for reductions in operating expense which may be expected to follow the reduction in tare weight. These steels, which develop strengths based on yield-point determinations running to a maximum of about twice the low-carbon structural steel, so far as they have been applied experimentally, have effected increases in the ratio of net lading to gross load up to about 80 per cent from the 70 to 75 per cent range customary in open-top cars.

The weight reduction thus indicated, however, is probably due to a larger extent to the life of the materials because of their superior resistance to corrosion, ranging from about two to six times the life of carbon steel under similar conditions, than to the increased tensile strength. The superior resistance to corrosion permits the reduction in thickness of sheets, the weight of which is determined not by strength or stiffness requirements, but by the necessity of providing a resonable minimum life in spite of the losses from corrosion.

These alloy steels all cost more than carbon steel which they replace—enough more, indeed, so that the first cost of the light-weight cars is considerably greater than that of cars of conventional designs and materials. Numerous attempts have been made to measure the value of the weight saving in terms of reduced operating expenses. The problem is a complex one involving the necessity for finding numerous bases for determining what part of the apportionment assigned to freight service in certain operating-expense accounts is going to be affected by a reduction in freight-car weights. In relatively few cases is the relationship a direct one. These apportionments involve the exercise of judgment and, hence, no single evaluation is likely to be accorded full credibility by all interested in the problem.

One factor which will bear heavily in the ultimate result can be given little weight in any attempt at estimating the economic value of the new materials in advance of experience. This is their effect on the cost of maintaining the cars during their useful life. No doubt, in some cases, the attempt at weight reduction will lead to too great a sacrifice of structural stiffness which may be the cause of expensive repairs during the life of the car. Assuming, however, a well-balanced structural design, the new materials may very well find their justification in the greater freedom from the need for expensive replacements which, in the case of open-top cars, begin to be felt in from seven to ten years after their construction new.

Even though the determination of the economic value of weight saved in car structures may continue to involve some uncertainties, the possibilities for longer service between heavy repairs would seem to be sufficient to justify the extensive application of the new materials in the construction of cars in experimental lots. The value of the durability factor in this respect should begin definitely to manifest itself within six or seven years.

Facts Necessary Before Conclusions Can Be Reached

Since the newspapers of the country carried an item concerning the fire which occurred on November 20 on the forward unit of the 3,600-hp. Diesel locomotive at Gallup, N. M., while pulling the Santa Fe Superchief on a test run westbound from Chicago to Los Angeles, there has been considerable speculation as to the cause of the fire. At this time no complete report of the investigation has been made public and, without such facts as an investigation may disclose, conclusions are not in order.

For many years the railroads have been using in-

ternal-combustion motive-power units in locomotives, rail cars and now in streamlined trains. It is only natural to expect that where a liquid fuel is used, a fire hazard greater than that experienced with coal is involved. The records of the past ten years contain numerous instances of gasoline fires on rail motor cars. In all fairness to the builders of the equipment involved it should be stated that in most instances they have been caused by man failures in servicing. It should also be pointed out that, in a few cases of fires or explosions on rail equipment using gasoline, the results have been fatal to employees. One of the advantages justly claimed for Diesel powered equipment is its relative freedom from fire hazard because of the low-volatile type of fuel used. And it is worth while recording that, to the best of our knowledge, the few fires which have occurred on Diesel powered equipment since it came into use have not resulted in any fatalities. It might also be mentioned, just as a sidelight, that roads operating oil-burning steam locomotives have also occasionally experienced fires which have resulted in damage to equipment, but as a rule such cases have been man failures in servicing.

A fire, such as that which occurred on the Santa Fe, is bound to attract considerable attention if for no other reason than that it happened on a new type of equipment. A careful consideration of the mechanical and electrical equipment on such a unit as a Diesel-electric locomotive discloses no reason why the design or the functioning of such equipment should, in itself, result in a fire, and, in all fairness to this type of motive power which is destined to play an important part in rail transportation, opinions as to the cause of such fires should properly be reserved until all of the facts surrounding each case are determined and thoroughly analyzed. It is unfortunate that the fire on the Santa Fe Superchief has given rise to so many contradicting rumors as to its cause.

Whatever facts the investigation of this occurrence may disclose, there is every reason to believe that they will carry no more fundamental condemnation of the Diesel locomotive, as such, than the instances of fires and fuel explosions on oil-burning steam locomotives are a fundamental condemnation of that type of power.

Conditioning Cars For Winter Service

The preparation and maintenance of freight and passenger cars for winter service was the timely subject considered at the November meeting of the Northwest Car Men's Association. It is no small task to keep cars in condition for safe and satisfactory service, even in the summer months, owing to present generally reduced forces and deferred maintenance. When these difficulties are accentuated by winter temperatures and adverse climatic conditions, however, car men are really "on the spot" and the success with which they get cars over the road with a minimum of failures and attendant train delays is a tribute to their courage, resourcefulness and faithful attention to many small details.

The necessity of reissuing instructions for winter operation may perhaps be questioned but, as pointed out in the paper, proper methods of procedure must be brought forcefully to the attention of car inspection and maintenance forces; certain revisions in the instructions may be required, based on the experience of the preceding season, and there are always a certain number of new or transferred men who must be instructed in the performance of their duties under unusually trying conditions. In cases where there is a division of work between various passenger terminals, a program must be carefully developed to avoid duplication of work or oversight of some important detail which may otherwise be neglected and cause a train delay.

Hot boxes, in both passenger and freight service, are much more frequent during winter months, and there is only one way to minimize difficulties from this source; namely, make sure that mechanical conditions, such as journals, brasses, wedges, dust guards and journal-box covers are correct, and see that the packing, and especially the oil used, is adapted to provide lubrication under low temperatures. The question of proper lubrication and how best to secure it always confronts car men; it is a source of wide differences of opinion, and probably will never be fully answered. For example, the subject of summer and winter oil vs. an all-year oil was argued at the meeting referred to, also the advisability of supplying free oil to the journals of cars which have been standing in transportation yards and thus to loosen the packing from the journals and prevent its rolling. In so many instances the thing which it would be desirable to do from a lubrication or an economy standpoint is rendered impracticable by conditions over which the car man has no control, and he must exercise a high degree of good judgment and business sense in getting the results desired without involving prohibitive expense.

The impracticability of using a summer and a winter oil, particularly on freight equipment, seems to have been quite well demonstrated. The seasonal change on passenger cars can be made, if desired, because only a relatively small number of cars is involved and they are almost entirely under the control of the owning lines, but, obviously, the thousands of freight cars owned cannot be changed over from one oil to another in the limited time available. The crying need is for the general use of an all-year oil which will remain fluid in winter and yet have sufficient body to provide lubrication under high summer temperatures—without being prohibitively high in price. Free oiling, or "cut-back" oil, should apparently be used only in extremely cold weather—it may then be a practical necessity—

when a limited amount will provide immediate lubrication and not affect the lubricating qualities of the regular oil during the balance of the season.

Comparative Costs of Locomotive Repairs

In a study on Comparative Costs of Steam Locomotive Repairs by districts prepared by the Section of Car Pooling, Federal Co-ordinator of Transportation, made in an attempt to determine the reasons for the higher maintenance costs in the Eastern District as compared with the Western District, it was found that data were not available by which a full explanation could be made. The report of the study suggests the need for the maintenance of better, more complete and uniform records which will permit of reasonably accurate comparisons between the locomotive repair performances of individual railroads or parts of railways.

The question raised by the recommendation that a further study of this matter be made to determine the kind of information needed, the manner in which it should be kept and the way in which it may be used with respect to fuel economy, locomotive utilization, and the economic life of steam locomotives raises a fundamental question on which there are likely to be wide differences of opinion.

It is evident, as the study in question indicates, that differences in operating conditions actually influence maintenance costs, whether measured on the basis of locomotive miles or potential horespower miles. The basic difference of opinion is as to whether the development of a formula by which performance in this respect on one railway may be compared with that on another will produce any facts by which appreciable reductions in maintenance cost can be effected by the individual railway managements, on whom the responsibility ultimately rests.

Co-ordinator Eastman, during his term of office, has evidenced a great curiosity as to what is going on in all of the various corners of the railway business; indeed, this is the job for which he was appointed. Many of his studies have brought to light information of a thought-provoking character which, no doubt will leave its mark on the future policies of railway managements. An attempt to develop a uniform basis on which to equate locomotive repair costs between railways with any hope of measuring the difference in results against numerical values of the factors affecting the results, however, seems more than likely to prove of doubtful value to the railways themselves. Even though a complete explanation of the differences were readily available it would not necessarily suggest the means by which the high--cost districts or high-cost roads can reduce maintenance costs, unless, indeed, the entire method of operation could be changed to suit the mechanical departments of the high-cost roads.

The desire on the part of the Co-ordinator to be able to judge the efficiency of management of the various railroads with respect to which he has certain responsibilities defined by law, can be readily understood. From the standpoint of the general welfare, however, it is questionable whether an attempt to call managements to account for differences in locomotive maintenance costs is justified. To the extent that such supervision is exercised, while the full responsibility for the results still rests with the individual managements, just so much is the sense of responsibility and the initiative of the individual managements decreased.

The kind of data by which the individual managements can find the weak spots in its own program of locomotive maintenance must be much more detailed than a lump sum figure, whether it be per locomotive mile or per potential horsepower unit. Intelligent control of locomotive repair costs must depend upon a knowledge of unit costs of many detailed operations entering into the completely repaired locomotive. Such costs not only bring to light efficiency of supervision and of locomotive utilization, and the effect of the characteristics of the railroads over which the locomotives are operated, but also the efficiency of the facilities with which the repairs are made.

NEW BOOKS

METAL CLEANING HANDBOOK. *By Robert W. Mitchell, Ph.D. Published by the Magnus Chemical Company, Inc., 150 South Avenue, Garwood, N. J. 214 pages, illustrated. Price, $1.00.*

The Metal Cleaning Handbook is intended to provide a ready reference and guide for the use of those directly interested in, or concerned with metal cleaning. It describes equipment, methods and materials and gives practical suggestions for their use. Several locomotive and car cleaning operations are illustrated.

CAST METALS HANDBOOK. *Published by the American Foundrymen's Association, 222 West Adams street, Chicago. 512 pages, 130 illustrations. Bound in red, semi-flexible cloth. Price, to non-members, $4.*

This Handbook is devoted exclusively to the properties and applications of cast materials. It brings to date information on castings and corrects much erroneous and obsolete data on which engineers base their calculations. These data are given in eight sections on recommendations to designers of castings, recommendations to buyers of castings, one section each on the properties and applications of cast iron, malleable iron, steel and non-ferrous cast metals, a cross-index of the material contained in the volume and an advertising section. The book contains many practical suggestions to the designer of castings and patterns. Its sections on the various metals give complete information on methods of manufacture, metallurgy, heat treatment and the properties and applications of the metals. Most of the sections are concluded with extensive bibliographies which include references to the technical literature of Europe and America.

THE READER'S PAGE

Marinac Slips Again

To the Editor:

I enjoyed your editorial in the September issue on Marinac's Rail Oddities; also the two letters taking shots at him.

In your September issue, where he illustrates passenger trolleys used on mountain railways in Wales, he shows the rider sitting on the westbound rail of the eastbound track, with the other end of his trolley rolling on the eastbound rail of the west bound track. They certainly must gage the distance between the tracks in Wales equally as close as the gage between the rails.

Mechanical Engineer.

P. S.—I could tell of catching a two-and-a-half-pound catfish between the jaws of the bottom brake connecting rod on one of our tenders, but better not if Marinac is to illustrate it.

Hose Reclamation A Money Saver

To the Editor:

An "Air Brake Foreman", in the October *Railway Mechanical Engineer,* takes exception to some of the hose reclamation methods used at the Pitcairn Shops of the Pennsylvania. He asks, "Why are the hose tested after being removed from the cars? It seems to me that the carman who took them off must have had some good reason, and, in this case, I think much time is lost in making the test, as the hose should be considered scrap."

Mr. Air Brake Foreman's conclusions are not only wrong but they also ignore the possibility of saving the railroads considerable money. All hose removed from cars are not removed solely on account of defective tubes. Many hose are knocked off with the angle cocks when draw bars pass; others have defective hose fittings; some are removed from dismantled cars. There are possibly other reasons for hose removal.

The writer is connected with the air-brake department of a large railroad and has noticed that many of the hose received for dismantling would pass A. A. R. Rule 56 visibility tests, so in July, 1935, we started testing these hose. The results obtained were both surprising and gratifying.

The man who strips the dismantled hose was instructed to cull out all hose that his visual inspection (A. A. R. Rule 56) showed as having no defects. As he picks up each hose preparatory to stripping it, he looks it over and if found apparently good, throws it to one side. Defective hose are, of course, stripped of their fittings. This inspection actually costs nothing, inasmuch as the man still maintains his production quota.

The hose which pass the visibility test are further tested by completely immersing in water and charging with 100 lb. air pressure. This test positively discloses porous tubes, sand holes in fittings, and other defects. The testing device used is a simple, shop-made outfit consisting of a water tank, air-connections and a dipping mechanism. The testing of each hose costs less than two cents direct labor. However, inasmuch as this second test is "squeezed in", and involves no additional payroll costs, or entails no reduced shop output, it can be considered as practically costing nothing.

The hose that finally pass both tests are applied to system freight train cars. It is admitted that these hose are not new, and if applied to foreign cars, A. A. R. Rule 62 would subject the road to a monetary loss. The hose are used in freight (not passenger) service where the brake-pipe pressure is usually far below the pressure used in testing the hose in the shop.

During a three-month period (July, August and September, 1935), 10,585 hose were received for dismantling. Of this number, 1,005 or 9.5 per cent were selected as meeting A. A. R. Rule 56 requirements. Of these, 895 or 89.1 per cent were successfully reclaimed, with repairs possibly consisting of applying a new gasket or renewing a stop pin. In other words, nearly 8½ hose out of every 100 destined for the scrap bins were saved for further service. "Air Brake Foreman" states that his shop mounts an average of 5,000 hose monthly, which means that about 60,000 hose are dismantled annually. Seemingly thousands of these hose are being needlessly scrapped.

The monetary saving is surprisingly large. A complete hose is charged out by the store department at $1.39. This cost includes the price of the tube, fittings, labor to assemble, and overhead expense. Using this price and ignoring the small cost for repairs, we saved $1,244.05 on 895 hose, or an average of $414.68 monthly during the three months period mentioned. Viewed from another angle, each new tube costs $0.755, so that we saved buying 895 tubes costing $675.72, or $225.24 monthly. These are not "paper" savings, but actual money.

During the past twelve months, we received 41,778 hose for dismantling. If this amount is received during the next twelve months and 8½ out of every 100 hose are reclaimed, the hose saved will number about 3,551 and the money saved (at $0.755 each), $2,681. Is this saving worth while?

Another Air Brake Foreman

Saving Delays Due To Hot Boxes

To the Editor:

In handling cars set out at wayside points due to hot journals, if it is found that a journal is roughened or cut, it is a problem to move the car without further delay to the train which picks it up again.

I have found that placing a stick of hot-box compound or common pin grease directly on top of the journal under a new bearing when it is applied will, in most cases, allow the car to be moved to a repair point without overheating the journal and causing further damage. In some cases we have been able to move the car to its destination without further attention.

I feel that this information is worth passing on as it may save the expense of shipping wheels and men to out-of-the-way spurs, avoid delay to important loads, and eliminate additional delay to a train picking the car up.

J. B. Searles.

Gleanings *from the* Editor's Mail

The mails bring many interesting and pertinent comments to the Editor's desk during the course of a month. Here are a few that have strayed in during recent weeks.

Visit Other Enginehouses

An enginehouse foreman makes this suggestion: "I believe that one of the best improvements in roundhouse work would be to require roundhouse foremen to visit other roundhouses at least one day each month, making it possible for them to get ideas they would be unable to get in a lifetime in one roundhouse."

Halleluiah, Amen!

Well, I see where Mr. Babson and some other master minds say that times are better and business is good and getting better. The stock market is coming out of a Rip Van Winkle, and almost any day I look for the railways to break into print with the headline that some important system has bought 50 new, modern steam locomotives, the first since 1928, and the other roads will follow suit by way of keeping up with the Joneses. With the delivery of the new power the enginehouse foreman's troubles will abate somewhat, and the passing of time will cause him to forget his troubles to the extent that ten years from now you will hear him tell the young bloods how he ran the place back in the hard times of '29 almost single-handed, and he will point with pride to how he practically saved the road by his unflagging zeal for 12 to 16 hours a day over a period of four or five years.

Roundhouse Coffee

There is one roundhouse institution that I have not seen mentioned; that is the "cup of coffee" which can be procured at any time and, I guess, at any roundhouse. Did you ever partake of "Roundhouse Coffee"? Let me describe it. You never know where it comes from, but take it for granted. It is not the kind advertised over a nation-wide hook-up, but still it generally hits the spot to the last drop. It is cooked in a pot made by the sheet metal worker. They don't sell pots within a reasonable price that are large enough and will stand the abuse. The water is generally drawn from a washout hose, and Heaven knows how long it has cooked. You drink it from a cup that would shock anyone but a roundhouse employee who is used to grime and grease. But for all that it is the main standby when the gang feels low. A poem should be written about it, or "Walt Wyre" should work it into one of his stories.

Short-Sighted Policy

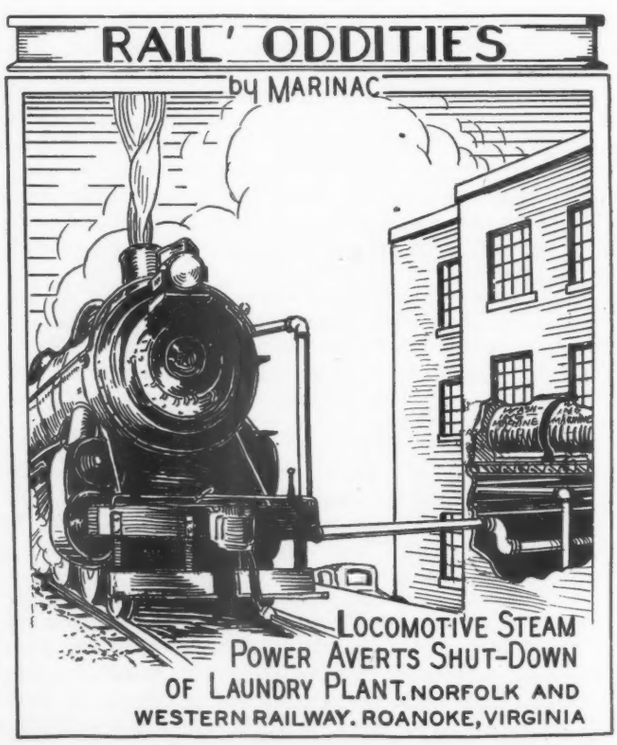
Our boiler foreman, who attended the Master Boiler Makers' convention, says over 100 were present, 33 of them entirely new members attending their first convention—very young and good material. But get this! The majority of all attending were paying their own expenses. He reported a most successful meeting, the most interesting picture being the informal discussions that were held late into the night by small groups having problems to discuss, but did not feel like doing so on the floor. He attaches much importance to these groups and, although an old hand himself at attending them, states he gathered much information and learned of more problems due to the four years' cessation of these conventions than he believed possible to accumulate in that time. The railroads are short-sighted in compelling their men to pay their own expenses to attend. Of course I understand they were not urged to attend; in fact, very few of the officials cared whether they attended or not.

How to Keep Up-to-Date

I read with interest the article covering the shopping and repairs to the Northern Pacific locomotive No. 2626, formerly Timken 1111. And less than two hours after I had read all about it in the *Railway Mechanical Engineer* I was asked by one of my associates what had become of that particular locomotive. It being fresh on my mind, I was able to give him all the details and quoted him a few figures by way of impressing him with what a lot I knew about the 2626; as a parting shot advised him to subscribe to the *Railway Mechanical Engineer* and keep right up-to-date on important mechanical matters.

More Miles Between Shoppings

By way of comment on the editorial on page 393, entitled "Challenge to the Mechanical Department" (September, 1935). The mechanical department can meet the situation with ease if the present locomotives are modernized to the extent that they can be used for longer periods of time between shopping. For instance, a one-piece steel engine bed with cylinders cast integral will get away from shopping engines to rebolt frame braces and cylinders and such laborious jobs as grinding in back cylinder heads. A few sets of roller bearings will overcome the driving boxes that "fly up" and run hot, no matter how painstaking the attention to packing and inspection, and also get away from the costly practice of dropping the main drivers all too often for the refitting of the crown brasses. There is need for tougher driving tires that will have better wearing qualities, yet not fail in service from fractures. The mechanical department will be "there with bells on" when it gets the equipment in the form of engines with more available hours of service built into them.


RAIL' ODDITIES
by MARINAC
LOCOMOTIVE STEAM POWER AVERTS SHUT-DOWN OF LAUNDRY PLANT. NORFOLK AND WESTERN RAILWAY. ROANOKE, VIRGINIA

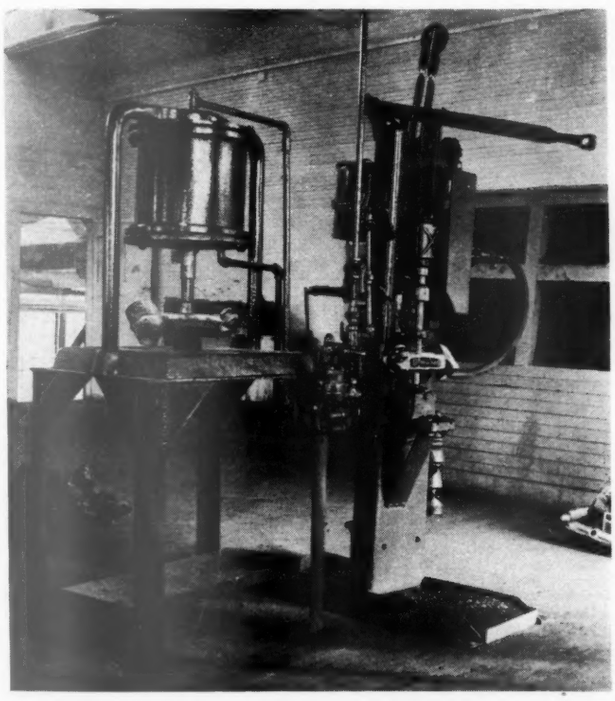
For explanation see page 522

With the Car Foremen and Inspectors

Bushing Freight-Car Brake-Beam Struts

TAKING up wear in worn brake-lever holes in brake-beam struts, by applying case-hardened bushings, has been made a simple operation by means of the drill and press jigs which are used at the Atchison, Topeka & Santa Fe shops, Albuquerque, N. M. The equipment consists of two units, one to bore out the hole in the strut to suit the bushing size, and the other to press the bushing in place.

The first unit is an upright 13-in. channel, made from an old car-truck spring-plank, to the outside face of



Small drill and press used in applying bushings to freight-car brake-beam struts

which has been welded a steel plate as a motor guide for a Thor close-quarter drill. This drill drives a long spindle or boring bar, with a cutting tool set to the exact size of the hole desired. The boring bar is guided by suitable sliding bearings attached to the channel, and a support for the strut is provided as shown. Motor and cutter feed is produced by the upper hand lever.

In operating this drill jig an old Viloco sander valve is used in which the ports have been changed to permit air to exhaust in either the top or the bottom position, thus operating a small air jack which raises or lowers the motor and cutting bar. The jig for holding the work is of exact size to fit the recess in the strut, which is then clamped in place with an air-clamp. This consists of a three-way valve to operate a U-shaped clamp through an old slack-adjuster cylinder and piston. A small sheet-metal container, mounted on the back of the channels, furnishes a supply of cutting compound which flows by gravity to the boring tool. A strut is placed in position, clamped, and the hole bored in a very short time.

The press for applying bushings is made from an old 12-in. by 12-in. brake cylinder, operated by an independent brake valve which also had the ports changed to permit control of the piston with one valve at a slow and safe piston speed. A small steel block is placed in the recess of the strut as a bushing stop. The advantages of repairing brake beam struts by this drill and press arrangement include speedy operation, a uniformly accurate job and the use of relatively inexpensive shop-made equipment.

Reclamation Of Car Material*

RECLAMATION is not a new subject with the railroads, and much progress has been made in this field during the past ten or twelve years. I think that if any department deserves the credit of being pioneers in this work, it is the department you men represent, the car department. You have practiced reclamation on your repair tracks for a number of years. You may not have called it reclamation, but it was reclamation nevertheless. At times you might have been forced into removing a bent and twisted forging from a car to straighten it, or weld a jaw on a brake rod or do some other job because the stores department did not have the particular item that was needed in stock. Whatever name you called it, it was bringing back, recovering or reconditioning material that otherwise would have gone into scrap, and keeping it in service. At present, repair tracks are equipped with at least one gas-welding outfit and a forge to take care of such items. There is still another phase of reclamation that can best be performed at the repair track, and I am glad to say it is my experience at the general scrap dock on our railroads, that a great deal of improvement has been made. I am referring to new material, such as nails, nuts, bolts, washers and castings getting in the scrap. Usually I think this is due to car repair men getting more material than necessary to do the job, and some of it finds its way into the scrap bin. I know it requires the vigilance of supervisors, and educating the men to avoid waste in this way, and I can say that during the past few years finding such items in the scrap is the exception rather than the rule.

There is a natural prejudice against using secondhand and reclaimed material. I think some of this can be

* Abstract of a paper presented at the September 9 meeting of the Northwest Carmen's Association, held Monday evening, September 9, at St. Paul, Minnesota. Mr. Hegeman is superintendent of the Chicago, Burlington & Quincy reclamation plant, Eola, Ill.

traced back to our younger days. I happened to be the youngest of three boys in our family, and money was not very plentiful—I was brought in contact with reclamation at a very early age, in fact, every article of clothing that was passed on to me was reclaimed, and not much attention was paid to color, style or fit.

Our early attempts at reclamation on the railroads were somewhat similar, not much attention was paid to standards or looks or to the service that could be expected from the reconditioned article. Using such material was left up to the car repair man or the man who actually applied the material, and I do not need to tell you that it was not popular and a lot of it not used. Reclaimed material must not only *be* good, but it must *look* good. This is the goal to which we are working. On our railroad reclaimed material from the reclamation plant is inspected by the engineer of tests, and the material is given the same tests and inspections as that given to new material. When a new item comes up for reclamation the engineer of tests gives the tolerance where necessary, approves gages for checking, and gives his approval before we can send the material out. In other words, if the engineer of tests OK's the item it is used. I know of no better method to maintain standards and to produce uniformly good work and material that can be expected to give the best service.

This inspection service, together with the constructive criticism from the user and last but not least, with the backing of the higher officers, cannot fail to bring about greater economies in reclamation.

There are phases of reclamation, that owing to cost of equipment, etc., cannot be performed at the repair

Gantry crane loading scrap car at Eola reclamation plant

tracks. I am referring to such items as brake beams, which must be tested for load on a special machine and checked with several A. A. R. gages to insure they meet the requirements; coil springs, that must be heated to a certain temperature in a pyrometer-controlled furnace, spread to the required height, tempered, and finally tested in a hydraulic testing machine; couplers, bent shanks straightened in a special straightening machine, wear on shanks built up by electric welding process, cracks in guard arm welded, welding cracks in head caused by tail of knuckle, and finally normalizing them in a heat-controlled furnace to relieve stresses in the metal; arch bars that must be reformed and normalized in a furnace; bolsters and truck side frames, cracks welded, worn parts built up, and these as well as all other steel castings which must go through a normalizing furnace to insure good service. It can readily be seen that it would not be practical to provide all the necessary equipment to several different repair tracks or shop points, but it would be economical to centralize the work when the quantity repaired or reclaimed would justify the machinery necessary. At a centralized point standards can more readily be maintained, proper inspection provided, reclaiming costs are lower on account of quantity production, and last but not least, material can be more readily controlled and distributed to points needed.

It might be of interest to you to know just how we know what material to reclaim. Material reclaimed at the reclamation plant is controlled by orders from the general store; in other words, the material reclaimed is for immediate use, and would be purchased if not available. We are not permitted to work on any material of any kind unless we have an order for it. This is to prevent spending money for labor on material that might not be used for some time.

Typical Work Done at Eola Reclamation Plant

Angle and cutout cocks—Loose brass bushings pressed in, bushings applied to trainline, and hose end when threads are worn.
Air reservoirs—Broken brackets welded on; pistons repaired.
Brake chains.
Brake levers—Holes plugged, reworked to size needed.
Hose couplings and nipples—Cleaned, checked and tested.
Hose clamps—Straightened.
Brake shafts.
Brake steps.
Bolsters, steel—Cracks welded; worn parts built up; normalized.
Bolsters, built up—Cracks welded; castings welded; reinforced when necessary.
Center plates—Straightened and welded.
Arch bars—Gaged for thickness of stock; normalized; reformed and checked.
Arch bars, scrap—Used for making carry irons, switch rods and miscellaneous purposes.
Body side bearings.
Center sills, steel—Channels used for highway crossings, structural steel, top plates for miscellaneous purposes.
Brake beams—Repaired; channels normalized and straightened; head and fulcrums welded; A. A. R. load test; checked with A. A. R. templates.
Brake shoes—Inspected, gaged ($^{7}/_{16}$ in. condemning limit for freight service; ¾ in. condemning limit for passenger service.)
Castings—All malleable castings built up with bronze; steel castings with electric arc; steel castings all normalized in furnace.
Hand holds—Gaged, straightened and inspected.
Gaskets—Triple valve gaskets boiled in caustic solution; cleaned in hot water; graphited; hard rubber gaskets refaced.
Dump door chains.
Door flashings—Made from old car roofing.
Brake rods—Made from iron coming in scrap.
Brace rods—Made from iron coming in scrap.
Journal box wedges—Radius cut on milling machine.
Journal boxes—Worn parts built up by welding.
Journal box lids—Straightened; springs applied.
Bolts—Made of round iron which comes in bent and twisted; straightened in machine and gaged; threads checked with thread micrometer once each hour at bolt machine; bolts cut to shorter lengths when threads are bad. Column bolts and oil box bolts welded to length, normalized in furnace and threaded.
Couplers—Shanks straightened; worn shanks built up by welding; cracks in guard arm welded; guard arms out of gage, heated and brought back to position; back wall welded; normalized in furnace.
Knuckles—Built up by welding process.
Angle iron from dismantled steel cars—Made into auto unloading devices; used for structural steel; roadway signs.
Truck sides—Cracks welded; worn parts built up; normalized in furnace.
Old car roofing—Made into stove pipe, fire pails, patching sheets, bridge covering, etc., car roof lock washers.
Door hangers—Welded; new rollers applied.
Side door plates—Made of flattened flues.
Old truss rods—Made into track tie rods.
Spring draft bolster—Gaged for stock size; reformed; tested in hydraulic testing machine.

The principal items of car material reclaimed are shown in the table. All bent and twisted round iron that comes in in the scrap which gages to size, is straightened and made into bolts, brake connecting pins, brace rods, brake rods, and, in fact, is used for any purpose that new iron is used, but it must gage to size. The same is true with flat iron. Car angles and channels are used in fabricating the frame-work for buildings of different kinds, making highway crossings over tracks, frame-work for clinker pits, and, in fact, used wherever possible.

All reclaimed material must meet the A. A. R. requirements at the time A. A. R. inspectors come to the plant to check reclaimed material, and the methods used

in reclaiming it. I want to stress the importance of maintaining standards, by inspection, by gaging, and by adhering strictly to the A. A. R. book of rules.

You men have the best opportunity to help. When you notice a certain casting repeatedly breaking in the same place, or any other car part failing due to faulty design, take the matter up for correction. You are on the ground, you are best fitted to analyze causes for such failures.

All items, such as castings, draft rigging, etc., are subjet to replacement if they fail to give proper service.

There is still much to be done in reclamation, and you can help even more than you have in the past. We all know the imperative need of economies, especially in these trying times when every dollar spent for material may mean fewer dollars for the payroll, and that means less men at work.

Two-Stage Reduction Regulator

THE Air Reduction Sales Company, New York, announces a new heavy-duty two-stage pressure-reduction regulator known as Airco-DB style 8490, primarily designed to deliver large volumes of oxygen at relatively high pressures, such as may be encountered on heavy cutting jobs. It is principally useful where the oxygen demand is greater than can be handled by the conventional regulator, or where close pressure regulation and a low end point are desired. A further and important use of the regulator arises in cases where precise pressure regulation with medium flows is involved. Whenever the oxygen demand per regulator is in excess of 1,000 to 1,200 cu. ft. per hr., the No. 8490 should be used even if low end point and close regulation are not essential.

Airco-DB, Style 8490 heavy duty pressure regulator

The maximum operating pressure is 200 lb. per sq. in., while the maximum delivery capacity is about 3,000 cu. ft. per hour, provided the delivery pressure is 100 lb. or greater. The pressure regulation is practically independent of the rate of flow from full cylinder pressure down to the regulation end point. The pressure variation will generally be less than plus or minus ½ lb.

This regulator uses the Airco "feed-back" principle. The low-stage cavity is connected to the space in back of the first-stage diaphragm by the passage through the control tube on the back of the regulator. The first-stage spring maintains a certain difference in pressure between the first and second stages, much in the same manner as in the usual two-stage welding regulator, although the pressure difference varies in the latter for different operating pressures. However, whenever the adjusting screw is turned in and pressure developed in the low-pressure cavity, the same pressure will be developed in back of the first-stage diaphragm, thus augmenting the effect of the control spring thrust so that the first-stage pressure increases by an amount equal to the operating pressure.

The effect of the control tube is the same as though the first-stage side of the regulator were equipped with an adjusting screw of its own and this screw were turned in the same amount as the operating-pressure adjusting screw (for equivalent characteristics, a long and heavy control spring would be required). With this arrangement, the difference between the first- and second-stage pressures is always maintained substantially constant, with a difference equal to the first-stage pressure when the adjusting screw is entirely released. This feature is largely responsible for the excellent regulation obtained because there is a definite relation between the first- and second-stage pressure which will give the best regulator characteristics. In welding regulators, the available pressure range is small compared to the pressure range of a cutting regulator, thus a varying pressure differential between the two stages is not as important as in the cutting regulator. By using the feed-back principle, the two stages keep pace with each other and the size and weight of the regulator are considerably reduced.

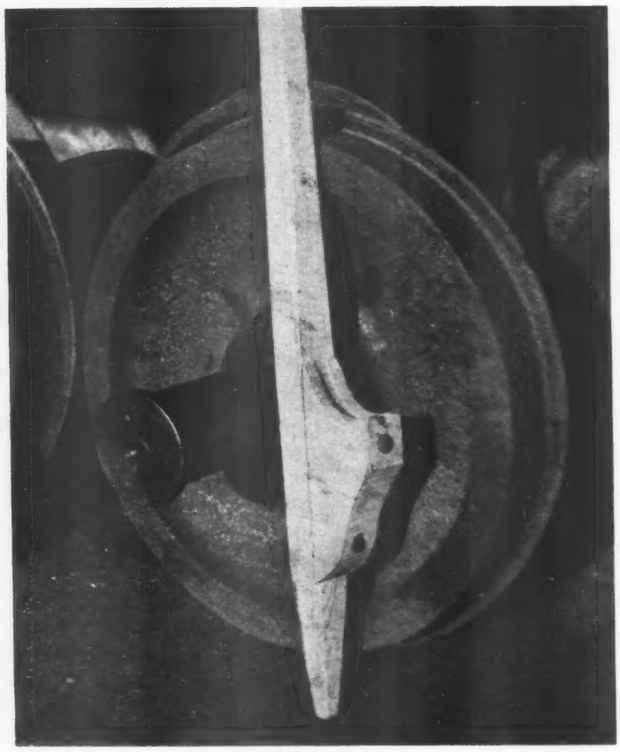
Stainless Steel Welding Rod

A STAINLESS steel welding rod, known as "Oxweld No. 28, Columbium Treated 18-8 Welding Rod," for welding chrome-nickel steels of the 18-8 type, is announced by the Linde Air Products Company, New York. This rod simplifies the fabrication of products from 18-8 stainless steel and improves the corrosion-resistance of the fabricated joint areas. The unique feature of the new Oxweld rod which makes it superior for this work is the inclusion of a definite quantity of the element columbium. Because of this feature, products fabricated from "treated" or "stabilized" 18-8 steel by welding with Oxweld No. 28 rod have full corrosion resistance and heat resistance in the as-welded condition. No heat treatment after welding is necessary.

Eliminating Oil Marks From Wheel Hubs

WHEN a car inspector notices any discoloration resembling an oil seepage mark on the inside hub of a car wheel he must necessarily shop the car to the repair track for wheel renewal on account of an apparently loose wheel on the axle. One railroad recently experienced an exceptionally large number of cars being shopped—placed on repair tracks where wheels were removed and sent to the wheel shops for remounting. An investigation conducted as to the cause for improperly

Painting inside hub of wheel and adjacent part of axle eliminates shop oil marks



Wheel stick touches only the axle collar and does not wipe off coating on the journal

fitted wheels developed that in a large majority of cases the wheels were not actually loose on the axle notwithstanding the fact that there were oil marks around the wheel fit, some of the marks being quite oily. It was discovered that the white lead with which the axle seat and the inside hub of the wheel had been coated prior to pressing the wheels on the axle at the wheel shop ran down over the inside plate of the wheel and in a few days became discolored and then had all the appearance of an oil seepage mark.

To overcome this condition arrangements were made to have all wheels leaving the wheel shops painted around the hub, about three inches high on the wheel plate and four or five inches on the axle with a dark brown or red paint. This practice eliminated the oil seepage marks and resulted in greatly reducing the number of wheels removed.

Should a loose wheel develop the fresh oil marks are then more easily detected over the brown or red paint than on the grey iron of the wheel plate.

Improved Wheel Stick For Car and Wheel Shops

THE handling of mounted car wheels at both the wheel shop and on the car repair tracks makes it necessary to use a wheel stick to turn the wheels across platforms etc. The conventional wheel sticks bear directly on the journals thereby wiping off the tallow or other types of journal protection which has been applied. While this makes little difference while handling wheels entering the wheel shops or leaving the shop before the protective coating is applied it is much more satisfactory to apply the protective coating in the shop.

The wheel stick shown in the illustration is made along the lines of the conventional wheel stick except that it has been grooved out in the center of the bearing surface to permit its use on the collar of the journal. The groove is only one-half inch deep and when inserted on the collar of the journal there is no chance of wiping the compound from the journal itself. Due to the smaller area of bearing surface at the collar of the journal it will be found that the wheels are much more easily handled. The compound that is wiped off of the journal collar while the wheels are being handled can be retouched by the wheel handlers much easier and more economically than that on the entire journal which is the case when the conventional stick is used.

Decisions of Arbitration Cases

(The Arbitration Committee of the A. R. A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.)

Missing Inside Dome Cover of Tank Car Concealed by Insulation Cover

On January 24, 1934, the Kansas City Southern applied a bolted type dome cover to MMGX car 210, account missing, and included charges for $13.35 and also $1.91 for express charges. The Stanolind Oil & Gas Company took exceptions to charge, basing contention

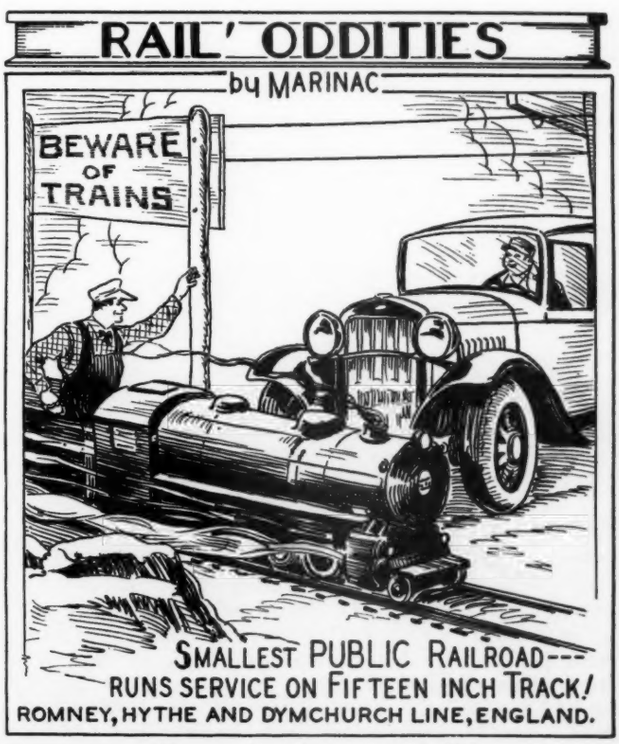
on Rule 32 which provides that missing dome cover is a handling line responsibility. The K. C. S. contended that dome cover and express charges are properly billable against car owner, account insulated car with insulation cover in place, under Rule 43, claiming concealed defect. Failing to reach an agreement, the case was appealed.

The Stanolind Oil & Gas Company stated that the K. C. S. wired on January 11, 1934, "Ship to general storekeeper, Kansas City, one dome cover for MMGX 210, now held our repair track carded by Missouri Pacific." However, they rendered bill covering value of this material, claiming missing dome cover came under Rule 43, account concealed defect. Rule 32 provides that missing dome cover is a handling line responsibility and billable against car owner, the only exception being that insulation cover, when missing, is owner's responsibility. The cover missing was not the insulation or false cover, but dome cover proper which bolts to dome head. They contended that it was not the intent of Rule 32 to exclude missing dome cover on insulated cars from handling line responsibility as insulation or false dome cover is excluded from being handling line responsibility and that same is owner's responsibility. To apply Rule 43 to missing dome cover would preclude owners from redress from handling line for missing dome cover or false insulation cover. It was also contended that had it been the intent of the Rules Committee that dome cover on insulated cars equipped with false cover be owner's responsibility when missing, they would have specifically mentioned this in Rule 32 or Rule 43. However, they have not done this, but have said that missing dome cover is handling line responsibility, except insulation cover.

The K. C. S. stated that car was received January 8, 1934, from Missouri Pacific at Kansas City and that dome cover was found missing, although insulated cover was in place. Not having dome cover standard to car on hand, they requested owner to furnish cover, advising that defect card was due from delivering line. However, after matter was considered further, it was decided that a missing dome cover on insulated car would be properly classed as an owner's defect in accordance with Rule 43 as this would be a concealed defect and could not be discovered in ordinary inspection. We advised Stanolind Oil & Gas Company that original report of missing cover as a handling line defect was in error due to provision in Rule 43 and advised that it would be necessary to bill owner for missing material. It is believed that Rule 32 has reference to unconcealed type dome cover discoverable in ordinary inspection. As missing cover was concealed, Rule 43 should apply and bill against car owner was proper. A report from the superintendent car department, C. & N. W., covering movement was submitted. Car was received from the Missouri Pacific at Omaha, January 3, 1934; inspected; left Omaha, January 4; again inspected, and arrived at Missouri Valley and once more inspected, no exceptions being taken. Car left Missouri Valley January 5 and was spotted and unloaded at Denison, being consigned to Standard Oil Company. Their agent stated that at the time no man was working for him and that cars received were unloaded by him personally. He had no recollection of this particular car, but was positive that no loaded car was received with dome cover missing. It was his practice to replace dome cover and had no recollection of failing to do so. He intimated that no one is infallible and that possibly the dome cover had been overlooked and not replaced. The agent at Denison reported that he had seen a round piece of iron lying in the yards for a considerable time in the spring, but not being familiar with car construction did not recognize it. Inspection of grounds failed to locate the dome cover. The section foreman in charge of section east out of Denison stated that he had seen a tank cover near some piles of ties in Denison yard, but yard was not under his jurisdiction. The foreman in charge of Denison yards said that he found a dome cover near a pile of ties, that he instructed his men to pick it up and take it to the scrap pile, and that it was later loaded with other material into a car accompanying monthly supply car. In the opinion of local agent and others concerned, inside dome cover was detached, possibly because of defective fastening, and in the unloading process was laid on top of tank or on running board. It was then evidently overlooked and not replaced by Standard Oil Company's representative. In later switching cover either fell off or was removed by some train crew. The car left Denison January 6, was inspected and arrived at Missouri Valley, then moved to Omaha where it was again inspected and no exceptions taken. Delivery was made to Missouri Pacific who inspected it and received car and cleared record.

In a decision rendered April 11, 1935, the Arbitration Committee said: "This missing dome cover was a concealed defect and, therefore, not subject to penalty in interchange under Rule 43. However, subsequent investigation by the committee develops that the dome cover was not replaced after car was unloaded at Denison, Iowa, as required by the provisions of Rule 3, Section (t-5), and also by the Interstate Commerce Commission Regulations for Transportation by Rail of Explosives and Other Dangerous Articles by Freight. The line on which car was unloaded should, therefore, compensate car owner for the cost of renewing the missing cover."—*Case No. 1740, Rules 3, 32 and 43, Stanolind Oil and Gas Company vs. Kansas City Southern.*

* * *



For explanation see page 522

In the Back Shop and Enginehouse

What Readers Want to Know About Diesel Locomotives

MANY readers of the *Railway Mechanical Engineer* have evidenced a desire to know more about Diesel engines and their use in locomotives and trains. In addition to such information as may be published from time to time pertaining to the descriptions of Diesel-powered equipment and facts concerning its operation and maintenance the editor extends an invitation to readers to send in questions on this subject. Every effort will be made to secure complete and accurate answers and the more interesting items will be published for the benefit of other readers. The following list is selected from a number of questions which have already been submitted:

1. *Q.—What is the essential difference between a Diesel and a gasoline engine?* A.—The gasoline engine vaporizes its fuel in a carburetor where it is mixed with air, compresses the vapor to a pressure of from 100 to 150 lb., and fires the mixture of vapor and air by electric ignition through a coil, distributor and spark plugs. The Diesel engine takes fuel oil and, through atomizers or pulverizers (fuel injector valves), breaks the oil up into a fine vapor. Air is first drawn into the cylinder and compressed by the piston to a pressure of from 450 to 550 lb. Compression always generates heat. At the top of the compression stroke the temperature of the air in the cylinder has reached a point sufficiently high to ignite the fuel the instant it is injected through the fuel nozzles. The injection of the fuel is properly timed, as is the spark on a gasoline engine, so that the ignition of the fuel takes place when desired. The Diesel has no carburetors nor electric-ignition system. Pressure is used both to inject the fuel and to ignite it.

2. *Q.—Why is a Diesel engine heavier than a gasoline engine?* A.—Because the compression and ignition pressures in a Diesel are so much greater than in a gasoline engine that heavier construction must be used to withstand the stresses.

3. *Q.—What sizes of Diesel engines are now built?* A.—From one horsepower to 20,000 hp.

4. *Q.—What sizes of Diesel engines are being built for railroad service?* A.—From 10 hp. to 2,000 hp.

5. *Q.—What sizes of Diesel locomotives are now being built for railroad service?* A.—From 10 hp. to 4,000 hp. In this country the range of sizes is from 60 hp. with one engine up to 3,600 hp. with four engines.

6. *Q.—What different systems of fuel injection are used on Diesel engines?* A.—Fuel injection systems are divided into two general groups—air injection (using high-pressure air) and solid injection. Of the solid injection systems there are four sub-divisions: (1) the common rail system; (2) the distributor system; (3) the individual fuel-pump system and (4) the unit-injector system. In the common rail system a single fuel pump takes the fuel oil from the reservoir or supply line and discharges it, at a pressure of, say, 1,000 lb. per sq. in., into a common fuel line. Each cylinder of the engine has a fuel nozzle which is opened mechanically at the proper time and admits the fuel from this high-pressure fuel line to the cylinder combustion space. Each of the other three systems involves the use of two fuel pumps, one to pump fuel oil from line or reservoir and deliver it at low pressure to the inlet side of a high-pressure fuel pump. In the case of the distributor system the high-pressure pump delivers the fuel oil to a distributor and thence in proper order to the individual cylinders. In system No. 3 each cylinder has an individual fuel pump with separate high-pressure fuel lines from pump to nozzle. In the unit-injector system No. 4 the high-pressure fuel pump and the injection nozzle are built as a unit one of which is attached to each cylinder head.

7. *Q.—What is a Diesel combination locomotive?* A.—A Diesel combination locomotive is a locomotive that derives its power from a combination of sources, including a Diesel engine. The various other sources of power may be from a storage battery, from compressed air or from an outside source such as third rail or overhead wire.

8. *Q.—What types of transmission may a Diesel locomotive have?* A.—The standard transmission for Diesel locomotives up to 200 hp. is a mechanical transmission similar to that of the ordinary automobile. The present standard for Diesel locomotives of 300 hp. and up is the electric transmission which has a generator coupled to the engine and electric traction motors on the axles. The hydraulic transmission is becoming popular in Europe on the small locomotives up to 300 hp. For the past 30 years locomotives have been built experimentally with pneumatic direct transmissions, but up to the present these have not been successful.

9. *Q.—Why does the Diesel consume less fuel than the steam engine?* A.—The Diesel engine is thermally much more efficient than the steam engine. That is, it converts a larger percentage of the heat of combustion of the fuel into power than does the steam engine.

10. *Q.—Why does the tractive force of the oil-electric locomotive go to such high values at very slow speed?* A.—The horsepower of the oil-electric power plant is constant and independent of the locomotive speed, therefore the tractive force-speed curve is hyperbolic, and rises to very high values up to the slipping point at slow speed. In addition, the factor of adhesion is high (30 percent) because of the smooth, uniform torque of the electric drive.

11. *Q.—Is the exhaust of a Diesel engine poisonous like the gasoline automobile exhaust?* A.—No. The poison in the exhaust of an automobile engine is carbon monoxide. The exhaust from a Diesel engine never contains more than minute traces of carbon monoxide.

12. *Q.— What are the principal wearing parts of the Diesel locomotive?* A.—The electric parts are generator and motor bearings, commutators, brushes and contactor tips. The mechanical parts are brake shoes, wheels, bearings and draft gear. The Diesel engine parts are bearings, pistons, piston rings, cylinder liners and valves. Auxiliary parts such as the lighting battery and certain portions of the air-brake equipment, etc., must be renewed periodically.

By **WALT WYRE**

"That's just the trouble," Johnson interrupted, "they haven't got one in the storeroom."

"POUND FOOLISH"

MOST roundhouse foremen dislike office work and Jim Evans, roundhouse foreman for the S. P. & W. at Plainville, is no exception. Jim considers letter writing and reports as necessary evils incidental to railroading, and—not always entirely necessary.

On this particular day he was sitting at his desk in the roundhouse office alternately chewing on one end of a pencil and scribbling with the other end. He was trying to answer a letter from the master mechanic wanting to know why he had run over his allowance for labor the previous month and having a hard time doing it. "Replying to your letter of November 4th, the reason for running over on our labor allowance in the month of September is——" and there he stuck. Five times he wrote that on a sheet of yellow clip and five times he had torn the sheets to bits and dropped them in the waste paper basket. He was starting on the sixth effort when Henry Johnson, a machinist, came in.

"Say, Mr. Evans, the 5086 needs a right valve bushing," the machinist told him.

"Well, why don't you put one in? Send down to the storeroom and get one and leave it in the machine shop to be turned. I'll——"

"That's just the trouble," Johnson interrupted, "they haven't got one in the storeroom."

"I'll take a look at it," Evans told him, glad of the opportunity to conscientiously postpone his letter writing.

"What seems to be the trouble? The valve bushing cut out?" Evans asked on the way over to the roundhouse.

"No, it's loose," Johnson replied.

Evans examined the bushing. No argument about it, the machinist was right, the bushing was loose.

"Well, pull it out," the foreman said. "I'll let you know what to do with it later."

EVANS went to the storeroom. "Say, Jack, how about some valve bushings for 5000's?" he asked Jack Marks, the storekeeper.

"Ought to be some in the next car," the storekeeper replied. "Car'll be in about Tuesday."

"Yeah, and today Wednesday. What am I supposed to use between now and then?"

"Well, it's the best I can do. I had them ordered in plenty of time, but they weren't shipped. I'll wire them on it," Jack said.

The foreman packed half a plug of "horseshoe" in his left cheek and headed for the roundhouse office. He checked the line-up. The 5086 had to be used on No. 9 the next day or else run the switch engine on the crack passenger. Jim's brows were wrinkled as he made his way back to the roundhouse.

"How much too small is the bushing?" Evans asked the machinist when he reached the 5086.

"Oh, mighty little, but enough to leak," Johnson replied.

Evans eyed the bushing reflectively, one eye half closed. "That might do it." He spoke his thoughts aloud.

"What's that, Mr. Evans?"

Jim drowned a passing bug with a deluge of tobacco juice before replying. "Take the bushing out to the

blacksmith shop. Tell Robinson to heat it a cherry red and bury it in lime to cool. Tell him to be sure and heat it evenly and cover it up good so it'll cool slow." Evans started up through the roundhouse.

He stopped at the board about the middle of the roundhouse, when Charlie Horton, an engine inspector, came up. "Figuring on using the 2811, Mr. Evans?" the inspector asked.

"Yeah, got to use her east tonight. Why?"

"Threads are stripped on a wedge bolt, left number three driving-box," Horton replied. "I put a slip on the hook," he added.

"I'll get Jenkins on it right away," Evans told the inspector as he started off to look for the machinist.

The foreman found Jenkins and gave him the work slip. The machinist sent his helper to the storeroom for the wedge bolt.

A few moments later the helper returned. "There ain't no wedge bolt at the storeroom," he announced.

"Hasn't he got one that we could use at all?" Jenkins asked.

"Hell no!" the helper replied. "He ain't got nothing down there except a mouthful of 'just outs.' The company would save money if they'd just put a phonograph on the counter with a record on it saying 'ain't got it'."

Jenkins hunted up the foreman and broke the news to him.

Evans swore. "Well, guess you'll have to rob one off the 2871. She'll be on the drop-pit three or four days. You and your helper may have to work overtime to get the job finished," Evans told the machinist.

The roundhouse clerk came up while the foreman was talking to Jenkins. "Master mechanic wants to know how you're getting along with the cab heaters," he said.

"Tell him O. K." Evans replied and went to the coppersmith shop more in hope than with expectation of finding the work up to schedule. Orders had been received three weeks before to have the work finished within thirty days.

Evans found Malone, the coppersmith, in the shop and out of humor. "How you coming with the cab heaters? About to get them all in?" the foreman inquired hopefully.

"Hell, no! Got 'em on about half of the engines," Malone replied grumpily.

"What's the matter—can't you get Henry to do the work?" Evans asked jokingly.

"My helper don't do my work. I do it myself, when I can get the material. It's bad enough trying to thread pipe with a set of dies George Washington throwed away for worn out, but when it comes to making close nipples, that's a little too much."

"I thought the storekeeper ordered a supply of fittings especially for this job," Evans reminded him.

"Maybe he did, but his idea of a supply of anything is one-twelfth dozen assorted. Why, if that storekeeper's wife had quintuplets, he'd want to send four of 'em back before time for inventory." Malone grinned at his own joke.

"Well, rush the job along all you can. I'll tell the storekeeper to prod them a little on the nipples. Anything else you're going to need?"

"Yeah, some three-quarter ells, ninety's and forty-five's, and if you think there's any chance of getting them, some half-inch, three-quarter and one-inch dies. I need a new eighteen-inch Stillson, too. The one I got would slip on lead pipe."

The last was spoke to Evans' back as he left the shop. It wasn't long until five o'clock and he wanted to answer the master mechanic's letter before the whistle blew. After that he'd be too busy checking work reports and leaving a line-up for Parker, the night foreman, to do anything else.

AFTER the necessary preliminaries of getting a drink of water, sharpening a pencil, and stuffing his left cheek full of "horseshoe," he sat down at the desk and began on a fresh sheet of paper: "Replying to your letter of November 4th, the reason for running over on our labor allowance for the month of September is—" At that he began to chew on the frayed end of the pencil. In the past few months he had used up all the stock excuses he could think of. Besides, the tone of Carter's letter didn't indicate that a stock excuse, such as high mileage engines, unexpected rush of business, poor grade of cylinder oil, would get over. Cold weather hadn't set in and there hadn't even been an engine derailment to lay some of the extra hours worked to.

The telephone interrupted the foreman's meditation. The clerk answered it. "Hello—yes—yes—all right. Yes—I'll tell him." Harris hung up.

"Who was it?" Evans asked.

"The chief clerk to the superintendent said they were sending a ditcher up here tonight on 81. Want it repaired, said it was a rush job, wanted to get it out right away," the clerk told him.

Evans made a note of the work in the "dope" book and started back to his letter writing. The five o'clock whistle blew and he went to the roundhouse to gather up work reports instead. On his way through the house he stopped at the 2811 to see how Jenkins and his helper were getting along. They had got the wedge bolt off the 2871 and were just starting to take the defective one out.

"They'll be a couple of hours," Evans reflected. That meant three hours pay at time-and-a-half.

NEXT morning as soon as the eight o'clock whistle blew, Evans sent Henry Johnson and his helper out to the blacksmith shop to get the valve bushing for the 5086. The foreman waited to see how the bushing was going to fit.

The machinist helper cleaned the bushing and he and the machinist pressed it in. Evans breathed more easily when he saw the amount of pressure necessary to force the bushing in the valve.

"Looks like it's going to be O.K.," Johnson remarked as he paused for breath.

"Yeah, it'll make a trip or two, all right, I guess, but it won't last long as a new one," Evans replied.

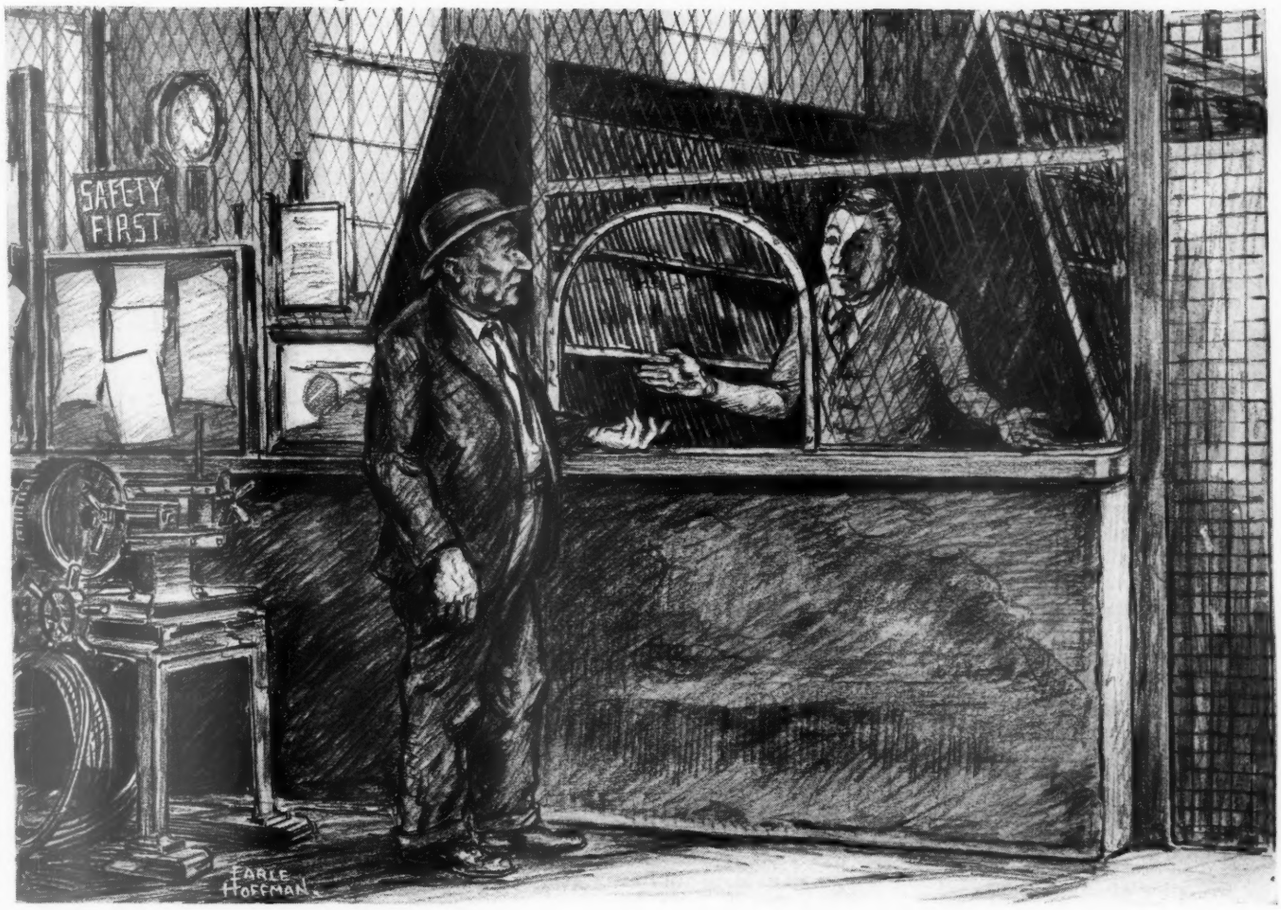
After being satisfied that the 5086 would do to run, the foreman went out to the north end of the roundhouse where the ditcher had been spotted to see how much work would be necessary on it. Machinist Jenkins and his helper had been assigned to do the work. The machinist had gone to the machine shop to get some bushings made.

The machine was of the endless track type made to run on the ground. A gasoline engine served as motive power and supplied the power for operating the machine also. The bearings had worn out in the wheels and roller on which the tread ran. The engineer and machinist helper were engaged in removing the treads.

"How much work do you have on it?" the foreman asked the ditcher engineer.

"Oh, if we can get the machine work done and some welding, we ought to get it out today. The superintendent sure is rearing for it, too. The road bed through Clear Creek cut is soft as a sponge. If we don't get the water drain out right away, the track's likely to sink out of sight."

At that instant Jenkins returned from the machine



"Well, it's the best I can do. I had them ordered in plenty of time, but they weren't shipped. I'll wire them on it," Jack said.

shop. "Well, we can get the bushings, I guess. Martin is starting right in on them. The other lathe will be tied up all day on running repair work. What else you got?"

"We'll have to have eight two-inch bolts, fourteen inches long, too. Tension adjusting bolts," the engineer explained, "and I don't believe they're standard threads, either," he added.

Jenkins picked up one of the bolts and measured the thread pitch. "Six threads to the inch," he announced. "They will have to be threaded in the lathe."

"Haven't you got a bolt threading machine?" the engineer asked.

"Yes, but the only six thread dies are for inch and a half," the machinist replied, "and both lathes tied up," he added.

"Yeah, if you let the bushings go and thread the bolts you couldn't get the bushings in time, and if you get the bushings you won't have the bolts," Evans said, "and we have to have the other lathe for work on engines. Might as well get the bolts, though," he told the machinist helper.

A few minutes later the helper returned with eight two-inch bolts; two, fourteen inches long; one each fifteen, sixteen, and seventeen; and three, eighteen inches long.

"Why didn't you get them fourteen?" Jenkins asked.

"Didn't have 'em. That ain't a storeroom; it's a sample room. He just carries one of each size of anything."

"Well, take the long ones in to the hack saw and cut them off to the right length," the foreman told him. "Let's go look at that bolt machine," he added to Jenkins.

They went in the machine shop. Evans and the machinist stopped at the bolt machine. "Say, put them inch and a half six-thread dies in the machine," Evans told Jenkins.

The machinist put the dies in. "The bolt won't go in."

"Now open the dies up far as they will go," the foreman interrupted.

When that was done, the two-inch bolt was still too large for the opening in the dies. It began to look as though they were stumped. Evans took a fresh chew of "horseshoe", squinted his left eye, and looked at the bolt machine. He picked up a bolt and placed it in the vise of the machine and ran it up to the dies. He pressed the starting button and shoved the bolt up against the dies. The cutters took hold and began cutting.

"How much thread you want on these?" he asked.

"About six inches," Jenkins replied.

Evans took a folding rule from his pocket and measured off eight inches from the bolt head and marked it with a piece of soapstone. Just before the mark was reached, he pressed the stop button on the bolt machine.

"How you going to get the bolt out?" the machinist asked.

"Take the dies out," Evans told him. "Go and get one of the nuts and let's see how they fit."

The threads were cut just a shade large. The fore-

man replaced dies and screwed down a little on the adjusting screw to close the dies. The next one fit perfectly.

"That'll get 'em," Evans told Jenkins. "It's a little slow having to take the dies out every time, but it's the best we can do."

EVANS went back down through the house. Everything seemed to be going O. K., so he went out to the office, determined to answer the master mechanic's letter.

He sat down at the desk and with the usual preliminaries started off: "Replying to your letter of November 4th, the reason for running over on our labor allowance for the month of September is——" Again he was stumped. He was tempted to say "too much work and not enough money", but knew that wouldn't go. While he was racking his brain for an answer, Ned Sparks, the electrician, came in.

"What time you figuring on using the 5077?" the electrician asked.

"She's called for one thirty p. m.," the clerk answered.

"Why?" Evans asked.

"Because the dynamo casting is cracked; won't do to run."

"Haven't you got time to put on a new one?" The foreman knew when he asked the question that it was unlikely that there was one in the storeroom.

"Yes, if I had one——"

"Well, you'll have to rob one off the 2871, I guess. It'll fit, won't it?"

"They are not the same, but I can make it fit with a little extra work," Sparks replied. "May not get it done before noon, though," he added.

"Well, you'll have to work noon hour to get it, then. How many men will you need to help handle it?"

"Need a couple and then a pipe-fitter to connect up the pipes. They are not the same, either," the electrician reminded him.

"Tell Malone to get it." Evans turned to his letter.

"That'll be four more hours overtime," Harris remarked. "We're having quite a bit of it, too—three hours yesterday, a machinist and helper on the 5086. We had some nearly every day last month."

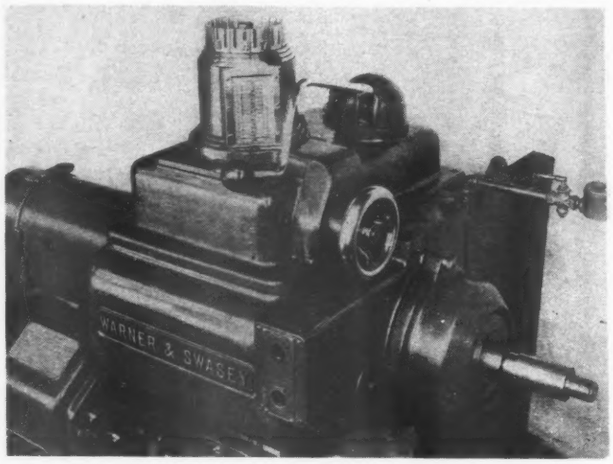
Evans thought a moment, pencil poised in air. Vision of work necessary to replace parts robbed from the 2811 came to him, making this and robbing that. He turned to the desk and wrote: "Replying to your letter of November 4th, the reason for running over on our labor allowance for the month of September is shortage of material, robbing and replacing parts, making parts that should be on hand in the storeroom and makeshift repairs that consume extra time without giving equivalent service which have cost more than the amount of overrun on allowance, and unless the condition is corrected, will continue to do so.

"J. E. Evans,
"Roundhouse Foreman."

Cutting-Speed Pre-Selector

A CUTTING-speed pre-selector for machine tools is announced by the Warner & Swasey Company, Cleveland, Ohio. This development provides for the operator single-lever control for not only shifting the gears, but for actuating the forward and reverse clutch. It also provides a built-in cutting-speed selector and a speed-sequence indicator.

The operation of the headstock by a single lever offers many advantages. Heretofore, three levers were used on a 12-speed head for shifting gears and a fourth lever for manipulating the forward and reverse clutch. This necessitated using both hands and the bending of the body in order to reach these levers. One single lever operates not only all the gears, but also the stop-start-and-reverse clutch. The operator stands erect in the working station and changes the spindle from one speed to the next by simply operating this one lever with his left hand. Heretofore, the operator has not always used the most productive speeds when shifting to the correct speed required the movement of all three gear-shift levers. With this single lever, a triple gear shift is as easy as a single gear shift, hence, the operator uses the correct speed.



Warner & Swasey cutting-speed pre-selector increases machine capacity

The cutting-speed pre-selector unit can be operated while the machine is in action. It enables the operator to choose the proper cutting speed and feed per minute for the next cut by the simple rotation of a hand wheel. Heretofore, the proper cutting speed was not always used because of the mental effort required to calculate the proper feet per minute from the available spindle speeds and the work diameter. In this calculator, the full range of work diameters is arranged stationarily on the left and right hand side of the window; the drum which rotates inside the housing indicates the proper feet per minute for each diameter in 12 vertical columns corresponding to the 12 speeds of the headstock. Selection of the proper cutting speeds requires merely rotating the drum until the proper feet per minute appear opposite the diameter to be machined. This operation sets the proper control for speed automatically. As soon as a cut has been finished, the operator can then shift the machine to the proper speed required for the next cut by simply pulling the single lever of the headstock.

A speed-sequence indicator is incorporated in a castellated drum on top into the slots of which numerals are inserted to indicate the several speeds required on the job consecutively. After a job has been set up, it is no longer necessary to set the indicator drum for each speed required—merely rotate the hand wheel until No. 1 is in front, pull the lever, then while the machine is in operation, bring No. 2 forward and when the machine is finished with cut No. 1, pull the lever and thereby have the machine ready for cut No. 2. Similarly No. 3

and No. 4 are consecutively brought forward. Until now, the operator has had to remember a series of complicated lever positions for consecutive speed selections and therefore has found it difficult to use more than three or four speeds on a given job. Through the use of this indicator, as many speeds as can be ideally used will be employed by the operator for he simply has to set the machine from one number to the next for each shift.

With the advent of higher cutting speeds, it becomes of importance to reduce the handling time of the machine and to facilitate its operation. This device is in line with this trend of development and its use will increase production.

Questions on Locomotive Design and Maintenance

TEN questions on the locomotive were asked in the October issue of *Railway Mechanical Engineer*, page 440, and the answers to these questions are given below. The editor will welcome questions dealing with locomotive or car shop practice—in fact, questions relating to any mechanical-department problem. The answers to any such questions as may be submitted by readers will be published in the proper department. On another page of this section will be found a series of questions and answers on Diesel motive power.

The Answers to the October Questions

1. *Q.—Under what circumstances are locomotive rods applied purposely slightly out of tram?* A.—On some narrow firebox locomotives that have the firebox between the frames, rods are applied a little longer than the center-to-center distance between the wheels when the locomotive is cold. This is to compensate for the expansion of that portion of the frames adjacent to the firebox.

2. *Q.—What nut on a locomotive is purposely left loose in assembling?* A.—The nut holding the locomotive throttle valve to the throttle stem is left loose, secured only by a cotter key so that the valve will be free to seat properly.

3. *Q.—For what type of service are locomotives suitable that have Walschaert valve gear arranged to be in the forward motion when the link block is at the top of the link?* A.—Switching service.

4. *Q.—Why are most locomotives with Walschaert gear arranged to take the forward motion from the bottom half of the link?* A.—If the link block is in the forward motion when in the bottom of the link, a failure of the radius hanger or reverse shaft will not cause a reversal of the engine when running forward.

5. *Q.—What gear in actual use is driven entirely from the crossheads?* A.—Young valve gear.

6. *Q.—What gear in actual use is operated by the eccentric crank and has no crosshead connection?* A.—Southern valve gear.

7. *Q.—What factors determine the minimum permissible thickness of a driver tire?* A.—The type of service and weight on the drivers.

8. *Q.—Where should the oil holes in truck brasses be located?* A.—Experience has shown that the oil holes should be well around on the side of the brass rather than on the top.

9. *Q.—An engineman's report says: "Front operating lever stuck." What part of the locomotive is referred to?* A.—The lever that operates the front coupler.

10. *Q.—Why is it often permissible to omit the shear keys on the high-pressure main-rod strap of a compound locomotive?* A.—The high-pressure cylinders of a locomotive seldom work any water and the bolts are not liable to such shearing strains as the rod bolts on the low-pressure main rods.

A Correction

The answer to Question 2 on page 364 of the August issue, which was published on page 440 of the October issue should read as follows: A.—The same results could not be obtained by drilling two holes, one 1/16 in. diameter and one 1/32 in. diameter, because the combined area of two such holes is only .00384 sq. in. whereas the area of a 3/32-in. hole is .0069 sq. in., a difference of .00306 sq. in. However, two 1/16-in. holes and one 1/32-in. hole would have a combined area of .0070 sq. in.

What Would You Have Done?

A LITTLE enginehouse drama, under the title of "What Would You Have Done?" was published in the *Railway Mechanical Engineer* of October 1935, page 423. The curtain dropped at the end of Scene III and our readers were asked what they would have done in administering discipline, had they been the S. M. P. One of our readers in a southern city comments in the following words on the attitude of the S. M. P. and then supplies what he believes should have happened in Scene IV.

"There is something off-color in the attitude of the S. M. P. in this sketch. I have been at the right hand of heads of the mechanical department for 25 years and I have never seen a man so unreasonable. The position he took could only lead to one thing, which I have developed as Scene IV. He trapped himself, but assuming that he is a man of good sense his action would be about as indicated below."

SCENE IV—IN THE S. M. P.'S CAR.

The S. M. P. pushed a button and his secretary entered, notebook and pencil in hand.

Bill Jones reached for his hat. The jig is up.

"Sit down," roared the S. M. P., "I am not through with you yet!"

Bill politely resumed his seat. His thoughts were none too cheerful.

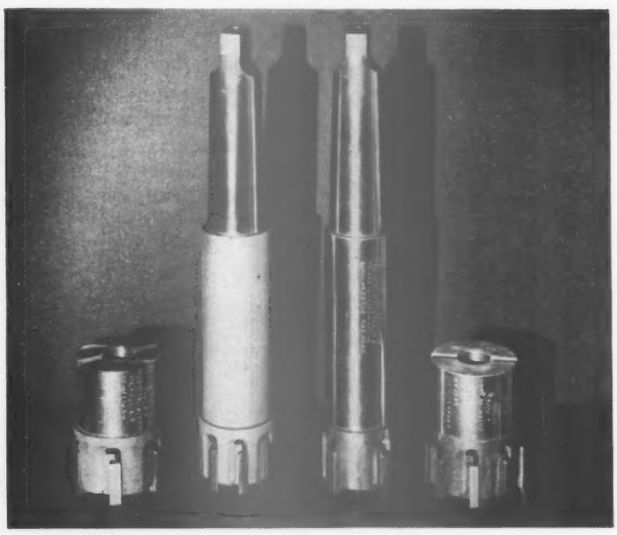
Turning to his secretary, the S. M. P. launched forth: "Take this bulletin and plaster it all over these shops yourself: 'Effective at once, William E. Jones is appointed Master Mechanic.' I want that bulletin up within the next ten minutes." The secretary vanished.

"Bill, you fired the best roundhouse foreman on the railroad, but I am hiring another Master Mechanic. The only way I can raise your pay is to change your handle." Glaring at Bill vindictively, he shouted: "Now that you've got what you want, get the H——l out of here."

Bill highballed, but his heart was singing for he knew that he had at last been received into that fraternity of true and tried, hard-bitten, loyal railroad stock which has built up and run the best railroads in the world.

Zee Lock Core Drills and Reamers

THE Zee lock cutter blades made by the Ingersoll Milling Machine Company, Rockford, Ill., are now applied to multi-blade boring tools such as core drills and reamers. These cutters may be reground to size by inserting the zee lock cutter black in the next slot, which



Ingersoll Zee-lock core drills and reamers

moves the blade out only part of a serration, thus minimizing the amount of regrinding to size. Eight to thirty-six adjustments or resizings are possible with one set of blades.

These core drills are made of either shank or of shell type. The coarsely spaced blades are set with rake and shear for free cutting. These reamers are also made either shank or shell type, only they have more blades which are set straight or with negative shear angle and irregularly spaced.

The housings or bodies are of forged and heat-treated alloy steel, while the cutter blades can be furnished of forged high-speed steel, super-cobalt high-speed steel, Stellite, or tipped with cemented carbide.

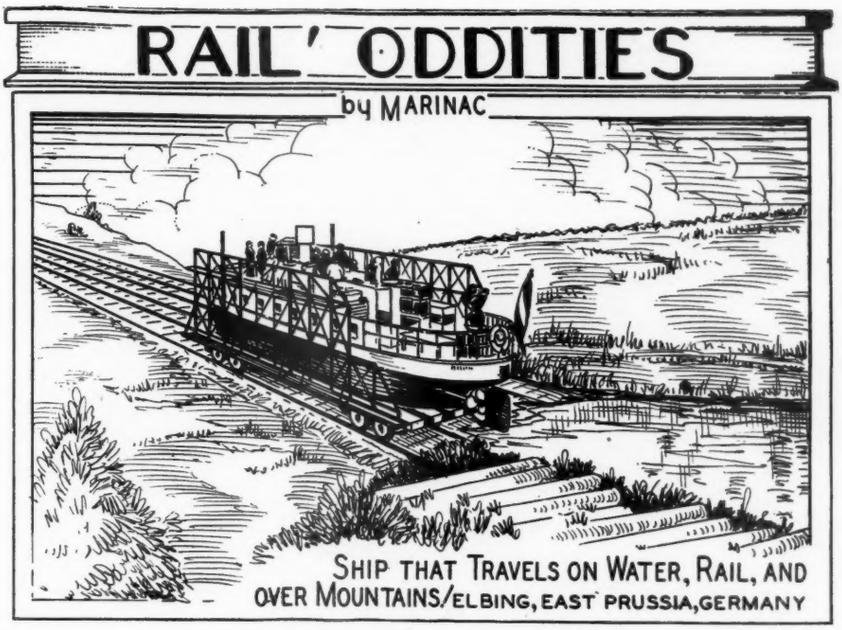
Planing Tender Journal Boxes

TENDER journal boxes which become worn in the pedestal ways are repaired at the Silvis (Ill.) shops of the Chicago, Rock Island & Pacific by planing off enough metal from the faces and sides of the ways to permit applying a $\frac{3}{16}$-in. pressed-steel wear plate which is securely welded in place.

In planing these boxes, they are clamped on a special holding jig in the planer, as illustrated, eight boxes being planed at one time. The base of the jig consists of a $3\frac{1}{4}$-in. by $8\frac{1}{2}$-in. steel bar which is accurately alined on the planer table by a tongue fitting into the table T-slot. The base bar is clamped firmly to the planer table, the clamping arrangement at one end being clearly shown in the illustration. The journal boxes are applied with one pedestal way straddling the base bar, while the other is being planed to remove any evidence of uneven wear and to provide space for the wear-liner application. Each box is placed on the base bar in such a way that it rests against two $1\frac{1}{4}$-in. stop plugs, screwed into the base bar and projecting 2 in. above it, these plugs serving to position the box and hold it against sliding under planer action. Special hold-down clamps are designed to engage projecting webs or flanges of the journal boxes, each clamp, except the first and last, helping to hold down two boxes. The clamps are tightened by nuts on 1-in. studs threaded into the base bar at the proper positions.

After one side of the boxes has been machined, the boxes are turned over and the other side completed in a similar manner. The journal-box set-up time is minimized by the use of this jig and, in addition, the boxes are securely held so that substantial cuts can be taken during the planing operation. High-speed steel cutting tools are used. The table speed is 18 ft. per min. and the feed $\frac{1}{8}$ in.

Planer set up for machining tender journal boxes



For explanation see page 522

NEWS

THE NEW YORK CENTRAL is having 1,500 cars repaired in its own shops at Avis, Pa., East Buffalo, N. Y., and Beech Grove, Ind.

THE READING is preparing to construct at its own shops in Reading, Pa., 25 all-steel caboose cars which will be equipped with Duryea underframes.

THE PENNSYLVANIA has awarded a contract to the Rust Engineering Company, Pittsburgh, Pa., for the construction of a machine shop building at Pitcairn, Pa.

THE UNION PACIFIC is rebuilding 2,447 box cars and 751 automobile cars, a considerable number of the cars having already been completed. Upon completion of this work the Union Pacific plans to convert a number of gondolas into hoppers.

THE CHICAGO, ROCK ISLAND & PACIFIC has contracted with the Ryan Car Company for the conversion of 170 box cars to single deck stock cars, the order being in addition to the 320 cars reported in the October issue of the *Railway Mechanical Engineer*.

THE SOUTHERN PACIFIC has authorized $1,100,000 for air-conditioning in 1936. Work has already started and upon its completion substantially all principal trains will be fully air-conditioned. In addition, arrangements are being made for an extension of the air-conditioning of Pullman cars operated in Southern Pacific trains.

THE NEW YORK CENTRAL recently has increased the number of men at its East Buffalo, N. Y., shops to bring the total up to 408 men at those shops, and also increased the number of men at the Beech Grove, Ind., shops to a total of 192. Later there will be a number of additional men employed at the Avis, Pa., shops.

THE CHICAGO, BURLINGTON & QUINCY has placed an order with the Cummins Engine Company, Columbus, Ind., for one dual power plant, Diesel-electric locomotive designed to develop a total of 900 hp. This locomotive, which is to be built at the Cummins plant, will be provided with electric equipment furnished by the General Electric Company. It will be placed in mixed branch line service on the Ft. Worth & Denver City.

THE ILLINOIS CENTRAL has been allotted $3,000,000 for air conditioning and maintenance work on equipment. This loan is in addition to $12,000,000 already loaned to the Illinois Central to create employment for its track and shop forces. The work to be done with the new loan will create employment for Illinois Central shop forces at Chicago, Ill.; Paducah, Ky.; Centralia, Ill.; Nonconnah, Tenn., and McComb, Miss. The work includes general repairs to 141 locomotives and tenders general overhauling and repairs to 56 passenger cars and application of air-conditioning to 52, and general overhauling and repairs to 1,297 steel underframe box cars.

Union Pacific's New Train to Start in April

THE two 11-car streamlined, light-weight trains being constructed for the Union Pacific by the Pullman-Standard Car Manufacturing Company will be delivered in March and placed in service in April between Chicago and Los Angeles, Cal., and Chicago and San Francisco, Cal. The Streamliner-City of Portland, which was taken out of service three months ago, will resume service between Chicago and Portland, Ore., around January 1.

Journal Bearing Protector — A Correction

IN the description of the Journal Bearing Protector appearing on page 471 of the November issue of the *Railway Mechanical Engineer* the name of the company should be the Lewis Bolt & Nut Co., Minneapolis, Minn.

Diesel Catches Fire on Test Run

ON November 20 the forward unit of 3,600-hp. Diesel locomotive pulling the Santa Fe "Superchief" on a test run westbound from Chicago to Los Angeles caught fire near Gallup, N. M. The final conclusions as to the exact causes of the fire have not yet been developed. The train was brought to an easy stop when the fire broke out and no one was seriously injured. The train was backed in to Gallup, where a steam engine was supplied, which pulled it to Los Angeles. The locomotive was held for several days at Gallup, N. M., for a careful examination of all parts which could be inspected. However, none of the parts was disassembled as this part of the investigation will be made at the plant of the Electro-Motive Corporation, La Grange, Ill., where representatives of the Santa Fe, the I. C. C.

Bureau of Locomotive Inspection and the locomotive builder will be present.

The fire, which occurred in the forward unit of the 3,600-hp. Diesel-electric locomotive hauling the test train did not damage the rear unit and only one of the Diesel motors in the front unit was damaged to any extent. The locomotive pulled a train back to Chicago, arriving November 26 and the damaged unit was then taken to the Electro-Motive Corporation plant for the disassembly inspection.

The run from Chicago to Los Angeles was being made preparatory to establishing a regular reduced schedule between those cities. President Bledsoe, Vice-Presidents Etter and Houghton, and other officers of the road and a number of guests were aboard.

The speed from Chicago to Kansas City, 451 miles, had averaged 65 miles an hour; from Kansas City to La Junta, 540 miles, the average was 65 miles an hour; from La Junta to Gallup, 509 miles in mountainous territory, the average had been 50 miles an hour. The run had promised to set a speed record between Chicago and Los Angeles, until the accident occurred.

The speed was limited to a maximum of 98 miles an hour, which repeatedly had been approached for long distances. President Bledsoe said that the accident to the Diesel would not stop the railroad's determination to inaugurate at an early date Diesel engine fast service between Los Angeles and Chicago.

Otto S. Beyer Appointed to Mediation Board

PRESIDENT Roosevelt on November 7 announced the appointment of Otto S. Beyer, who for the past two years has been director of the Section of Labor Relations in the organization of the federal co-ordinator of transportation, as a member of the National Mediation Board, succeeding John F. Carmody. Mr. Beyer has had a long experience in railroad labor relations matters, after an extensive experience in mechanical, experimental, and personnel work, and from 1920 to 1933, when he joined Mr. Eastman's staff, he was engaged as a consulting engineer, first in New York and later in Washington. He was born at Woodridge, N. J., on September 18, 1886, and was educated in the public schools, Stevens Preparatory School, and Stevens Institute of Technology, from which he received the M.E. degree in 1907. After graduate work at the Universities of New York and Pennsylvania, he was a machinist apprentice with the E. W. Bliss Company, Brooklyn, N. Y., the Midvale Steel Company, Philadelphia, Pa., and the Erie Railroad. He later became special motive power engineer with the Erie, foreman of a district shop of the Chicago, Rock Island & Pacific, and in 1916 was placed in charge of the railroad engineering experiment work and the locomotive testing laboratory at the University of Illinois. During the World War he participated in the organization of the U. S. School of Military Aeronautics and later he was called into the service of the army, with the rank of captain, to organize and train technical personnel for railway and heavy artillery maintenance. During 1919 he acted with the railroad labor organizations in devising a plan of co-operation with the U. S. Railroad Administration, and he later served as engineering counsel for the shop craft unions and other labor organizations. He was also managing director of the Railway Labor Research Foundation.

Otto S. Beyer

Supply Trade Notes

THE LINK-BELT COMPANY has moved its executive offices from 910 South Michigan avenue to the Bell building, 307 North Michigan avenue, Chicago.

FRANK J. FOLEY, vice-president in charge of sales of the American Locomotive Company, New York, has been elected a director of the company.

HENRY W. FOULDS has been elected vice-president of The Permutit Company, New York. Mr. Foulds will correlate and direct all sales, promotion and advertising.

KEITH J. EVANS, manager of sales promotion of Joseph T. Ryerson & Son, Inc., has also been appointed manager of the sales promotion division of the Inland Steel Company.

JOSEPH M. BANDISH has been appointed director of sales of the metallic packing division of the Felt Products Manufacturing Company, with headquarters at 1508 Carroll avenue, Chicago.

J. HOMER PLATTEN has been appointed executive assistant to the president of the American Car and Foundry Company. Mr. Platten recently resigned as assistant to comptroller of the Westinghouse Electric & Manufacturing Company.

FRANK V. BUSH, sales office manager of the Allegheny Steel Company, Brackenridge, Pa., has been promoted to the position of service manager, succeeding M. E. Harris, who was recently appointed assistant general manager.

J. D. MCGILLIS, assistant manager of the Montreal Locomotive Works, Ltd., Montreal, Quebec, Canada, has been appointed works manager and William Townsend has been appointed superintendent.

SAMUEL P. GOODLOE has been appointed representative of the Union Metal Products Company, the Railway Metal Products Company and the Standard Railway Equipment Company, with headquarters at Richmond, Va.

N. H. ORR, until recently a member of the staff of the American Iron & Steel Institute, New York, has been appointed general manager of sales of the Colorado Fuel & Iron Company, with headquarters at Denver, Colo.

J. H. SMITH, manager of the Boston branch of the West Disinfecting Company, Chicago, has been appointed eastern representative in charge of railroad department sales, with headquarters at 51 Commercial Wharf, Boston, Mass., and 42-16 Barn Street, Long Island City, N. Y.

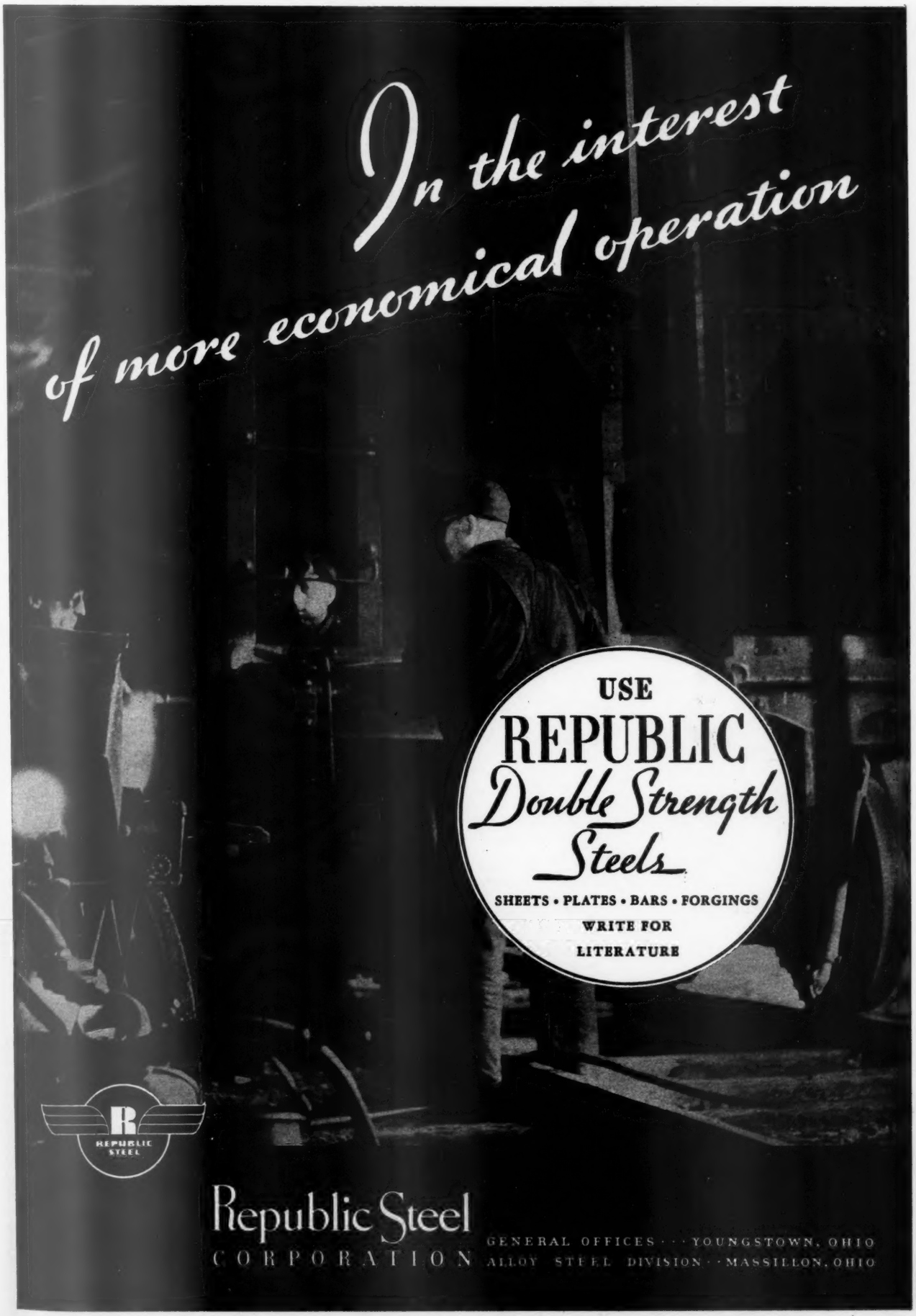
THE THWING INSTRUMENT COMPANY, Philadelphia, Pa., makers of pyrometer apparatus, has changed its name to the Thwing-Albert Instrument Company. Dr. Charles B. Thwing is president and Edward J. Albert, whose name is now joined with Dr. Thwing's in the firm, has been associated with the company for the past 17 years as manager and secretary.

FRANK F. CHILES, formerly manager of sales of the Bar division of Corrigan, McKinney Steel Company, has been appointed assistant manager of sales of the Bar division, Republic Steel Corporation, with headquarters at Youngstown, Ohio. In his new capacity, Mr. Chiles will assist W. F. Vosmer in supervising the sales of all carbon semi-finished steel bars, shapes and plates produced by Republic.

THE PAINT DIVISION of Aluminum Industries, Inc., Cincinnati, Ohio, manufacturer of Permite Aluminum paint has appointed C. L. Welch, Lee S. Abbott and George E. Fox as district managers. Mr. Welch will contact the trade in Minnesota, Wisconsin, Michigan, Indiana, Illinois and Ohio, with headquarters at the Chicago branch office. Mr. Abbott will represent Permite in Kansas, Missouri, Oklahoma, Arkansas, Louisiana and Texas, with his headquarters at 308 Wright building, Tulsa, Okla., and Mr. Fox will cover the territory along the Atlantic seaboard, including that portion of the country east of Pittsburgh and as far south as Virginia. His headquarters will be in the office of Aluminum Industries, Inc., in New York City.

THE DEARBORN CHEMICAL COMPANY, Chicago, has purchased the Electro-Chemical Engineering Corporation from the Pyle National Company, and will operate it as a subsidiary company to market the

(Continued on next left-hand page)


In the interest
of more economical operation
USE
REPUBLIC
Double Strength
Steels
SHEETS • PLATES • BARS • FORGINGS
WRITE FOR
LITERATURE
REPUBLIC STEEL
Republic Steel
CORPORATION
GENERAL OFFICES · · · YOUNGSTOWN, OHIO
ALLOY STEEL DIVISION · · MASSILLON, OHIO

Gunderson foam-meter and all other products of the Electro-Chemical Engineering Corporation, associated with the scientific treatment of boiler waters. L. O. Gunderson, vice-president of the Electro Chemical Engineering Corporation, has become associated with the Dearborn Chemical Company as assistant to the vice-president and consulting chemical engineer.

SYDNEY BUCKLEY, formerly vice-president and general manager of the Niles division, at Philadelphia, Pa., of the Shepard Niles Crane & Hoist Corporation, has been elected president of the corporation, and Herbert W. Gledhill, formerly manager of the Philadelphia district office, has been elected vice-president and general sales manager, both with headquarters at Montour Falls, N. Y.

R. H. GARDNER, division manager of the Washington, D. C., office of A. M. Byers Company, has been transferred to Pittsburgh, Pa., as manager of steel pipe sales; and E. L. MacWhorter, manager of the Philadelphia division, has been transferred to Washington, where he will head the combined activities of both divisions now known as the Washington division. District representatives will be maintained, as formerly, in Baltimore, Md., and Philadelphia, Pa.

O. R. WIKANDER has been awarded the Melville Medal for 1935 by the American Society of Mechanical Engineers for his paper on Draft Gear Action in Long Trains. The paper, presented at the 1934

O. R. Wikander

annual meeting, covers investigations sponsored by the Edgewater Steel Company, Pittsburgh, Pa. The medal is provided by an endowment established by Rear Admiral George W. Melville, a past president of the Society.

THOMAS W. DELANTY, who has been covering the eastern territory since 1930 for Joseph T. Ryerson & Son, Inc., Chicago, has been appointed manager of eastern railroad sales with headquarters at Jersey City, N. J. Mr. Delanty has been with the Ryerson company since 1918. He handled the export business in China and Japan for the Machinery division until 1925, since which time he has been in its railroad sales division. During the war period Mr. Delanty served in the Naval Ordnance as chief inspector of munitions, guns, and sight mechanisms.

JOHN F. RAPS, who has been appointed vice-president of the Okadee Company and the Viloco Railway Equipment Company, with headquarters at Chicago, entered railway service as a special apprentice in June, 1900, with the Burlington, Cedar Rapids & Northern, now a part of the Chicago, Rock Island & Pacific. In July, 1904, he

Moffett Studio

John F. Raps

resigned to accept a position with the Toledo, St. Louis & Western at Frankfort, Ind., and in April, 1905, he entered the employ of the Illinois Central at Waterloo, Iowa. In April, 1909, he was appointed general locomotive inspector, with headquarters at Chicago, and in July, 1930, resigned to become central manager of the Okadee Company and the Viloco Railway Equipment Company, which position he held until his recent election to the vice-presidency.

C. A. CHERRY, assistant manager of sales, Carbon Bar division of the Republic Steel Corporation, has been appointed district sales manager in the Buffalo, N. Y., territory, succeeding Thomas B. Davies, who has been transferred to Republic, Alloy Steel division, Massillon, Ohio, as special representative.

A. E. MUNCH, JR., has been appointed district manager of the New York branch and manager of the Export department of the Garlock Packing Company, Palmyra, N. Y. Mr. Munch served as Chicago branch representative of the company, handling northwestern railroad and industrial accounts, until his appointment as branch manager at Palmyra. S. E. Anderson, representative of the company in western Canada at Winnipeg, Manitoba, has been appointed district manager of the Palmyra branch, with headquarters at Palmyra.

THE KLASING CAR BRAKE COMPANY, Chicago, has concluded an arrangement with the Vermilion Malleable Iron Company of that city, giving the latter company exclusive rights to manufacture and sell Klasing hand brakes throughout the United States, Canada and Mexico. District sales representatives will be located in New York, Philadelphia, Pa., Washington, D. C., Boston, Mass., Richmond, Va., Roanoke, St. Paul, Minn., St. Louis, Mo., Denver, Colo., and San Francisco, Cal.

ROBERT J. WORKING, district sales manager of the Republic Steel Corporation, in the Cincinnati, Ohio, territory, has been appointed district sales manager in the Birmingham, Ala., territory, succeeding Kenneth D. Mann, who has resigned to become executive vice-president of the Truscon Steel Company. Paul R. Johnston, of the Cincinnati office of the Republic Steel Company, succeeds Mr. Working as district sales manager in the Cincinnati territory. Charles W. East, of the Birmingham, Ala., office, has been appointed assistant manager of sales in Republic's Pipe division, succeeding George E. Clifford, who has been appointed district sales manager in Los Angeles, Calif., territory.

Obituary

ARTHUR WYMAN, assistant to the president of the Chicago Railway Equipment Company, Chicago, died suddenly on November 19.

ROBERT TIFFT TURNER, vice-president and general sales manager of the Shepard Niles Crane & Hoist Corporation, Montour Falls, N. Y., died in New York City on November 13, at the age of 49 years.

CHESTER A. CROFT, sales representative for the Railroad division of A. M. Byers & Company, with headquarters at Pittsburgh, Pa., died on November 25 at the Valley Hospital, Sewickley, Pa.

GEORGE H. GREEN, president of the National Waste Company, Chicago, died in that city on October 13 of heart failure. Mr. Green was born in Chicago on De-

Matzene Studio

George H. Green

cember 19, 1886, and began his railroad career in the testing department of the Chicago, Rock Island & Pacific at Chicago, where he served 12 years as inspector and chief inspector. In 1914, he resigned to become railroad representative of the Garlock Packing Company. In 1916, he entered the employ of the National Waste Company as a representative and during the war served as a lieutenant from June, 1917, to June, 1919. In the latter year he returned to the National Waste Company as vice-president, which position he held until 1922, when he was elected president.

(*Turn to next left-hand page*)

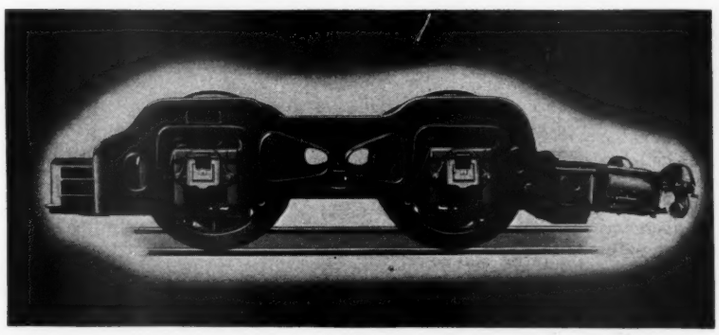
BALANCED POWER *cuts* FUEL COSTS

Locomotive cylinders correctly proportioned for road speeds, with the extra power needed for starting and accelerating provided by the Locomotive Booster, insure a power unit of maximum fuel economy and minimum maintenance.

A motive power unit such as this is properly balanced as to power required for both road speeds and starting ranges.

It permits of a lighter unit that is working at its maximum fuel efficiency all of the time it is hauling its train.

This fuel efficiency is available in any locomotive whether for heavy freight or light high speed service.



Franklin parts fit—In applying them there is no labor cost for fitting. They are built to original dimensions of carefully selected materials—they avoid road failures and excessive maintenance.

FRANKLIN RAILWAY SUPPLY COMPANY, Inc.
NEW YORK CHICAGO MONTREAL

Personal Mention

General

H. M. SMITH, master mechanic of the Saskatoon division of the Canadian National, has been appointed acting superintendent of motive power and car equipment of the Saskatchewan district, with headquarters as before at Saskatoon, Sask.

J. C. HASSETT has been appointed assistant to general mechanical superintendent of the New York, New Haven & Hartford, with headquarters at New Haven, Conn. It was incorrectly stated in the November issue that Mr. Hassett had been appointed assistant to general mechanical engineer.

WILLIAM ELMER, special engineer on the staff of the chief engineer of the Pennsylvania, retired from active duty on November 1. Mr. Elmer was born at Trenton, N. J., on September 29, 1870. He is a graduate of Princeton University (1892) and Princeton Electrical School (1895). He first entered the service of the Pennsylvania during the summer of 1892 as a fireman and subsequently became an apprentice at the Meadows Shops, near Jersey City, in 1896. He served successively as special apprentice at the Altoona Works; general foreman of electric car service of the West Jersey & Seashore (now P. R. R.); assistant master mechanic at the Altoona machine shops. In 1903 he was appointed assistant engineer of motive power at Altoona, Pa., and in 1906 became master mechanic of the Pittsburgh division. In 1911 he became superintendent of motive power of the Buffalo and Allegheny division; from 1917 to 1926, was superintendent, successively, of the Schuylkill, Philadelphia and Middle divisions, and in January, 1926, was appointed special engineer at Philadelphia. Mr. Elmer is a member of the American Society of Mechanical Engineers and is the author of an A. S. M. E. paper entitled "Avoidable Waste in the Operation of Locomotives and Cars."

William Elmer

Master Mechanics and Road Foremen

W. ALEXANDER has been appointed master mechanic of the Saskatoon division of the Canadian National, with headquarters at Saskatoon, Sask., to succeed H. M. Smith.

P. BAKER, general foreman on the Belt Railway of Chicago, has been appointed master mechanic of this company and the Chicago & Western Indiana, with headquarters at Chicago.

F. K. MITCHELL, master mechanic of the Cleveland, Cincinnati, Chicago & St. Louis, at Indianapolis, Ind., has been appointed also master mechanic of the Indianapolis Union.

Car Department

W. C. VANHOOK, assistant car foreman of the Interstate Railroad Company, has been appointed general car foreman, with headquarters at Andover, Va., succeeding M. D. Wampler, deceased.

MARINAC'S RAIL ODDITIES

MARINAC has furnished us with the following explanation of the three cartoons which appear elsewhere in this issue:

Page 506. It was not necessary to shut down the plant of a laundry and dry cleaning company at Roanoke, Va., for the mere matter of overhauling a boiler. Instead of closing the place, a Norfolk & Western Railway locomotive was called into service. It backed up to the plant's coal dump and the necessary steam connections were made for the locomotive to keep the plant running.

Page 511. England's little railroad, the Romney, Hythe & Dymchurch, which runs on a 15-in. track, could lay a double track between the rails of a standard track. The standard track measures 4 ft. 8½ in. from rail to rail, or nearly four times the distance between the rails on the Romney line.

Page 519. World travelers who have the time and money to go places and see things wonder why more people do not go out of the beaten path of travel to ride on a little boat that makes regular trips in that part of Germany known at East Prussia and which skirts the much discussed Polish Corridor. The boat itself is not unlike hundreds of other steamers that ply the rivers and lakes of Europe, but the route that it covers—and its manner of getting over that route—provide thrills that passengers never forget. The craft not only plows through the waters of canals, rivers and lakes, but at times, leaves the water and climbs over the slopes of hills and mountains—a man-made amphibian monster. During its 100-mile round-trip journeys from the town of Elbing to communities further south and inland, it passes over the foothills of five mountains and manages the high and dry portions of the "voyage" as well as those stretches which it covers in the water and under its own power.

Years ago when the little steamer was built, engineers had surveyed the route that it was to travel and decided that it would be impractical to build locks between the various bodies of water along the way. No less than 20 locks would be needed to raise and lower the boat over the mountains and the cost would have run into millions of dollars. Why not, they said, lay rails between the stretches of water and take the boat for a ride overland when it came to the end of a lake or the headwaters of a canal? It would not be a difficult engineering feat to build a strong cradle for the little steamer and lay the rails so that the boat could sail into the crade—which could be firmly fastened to a sort of overgrown flat car—and be pulled by cable out onto the railway line and over the hills to the next navigable lake or stream. The cost of such a system would be only a fraction of the expense of locks. Much time would be saved in making the trip and the passengers would get a great kick out of "coming round the mountain," from which they could look down on the neat little villages nestling in the valleys.

The trial trip was a complete success. The engineers had done their work well and the series of power plants they built along the way made easy work of pulling the boat out of the water and up the mountain sides. The network of tracks was equipped with strong steel cables which were hooked to the cradle. The cable was wound around huge drums in the power plants, and when the machinery was put into motion, the steamer moved out of the water and over the land as though drawn by some gigantic but gentle hand. When the steamer has to travel down hill, it is necessary, of course, to pay out cable from the big drums and keep the boat snubbed so that it will not go rolling down the rails of its own weight. Powerful brakes keep the descending steamer in control at all times.

The natives of East Prussia have become used to riding on the boat that travels on land as well as in the water, and they have no fear of an accident while they are riding up the side of a mountain, or down the other side. Sometimes, however, travelers who are making the trip for the first time wax exceedingly nervous when the boat quits the water, and they have to be assured by the skipper that the mechanism is strong and in good order and that there is not the slightest danger that the cable will break. Even if it did, there would not be a shipwreck on land, because the cradle is fitted with highly efficient emergency brakes that would cramp against the rails and stop the boat dead before it could roll its own length.

The good people of Elbing are as proud of their mountain climbing boat as they are of their iron foundries and their locomotive works. Visiting celebrities are always taken for a ride on the curious craft and all travelers who find their way that far north in Germany are urged to plan their itineraries so that they can make a trip, the like of which is not to be had anywhere else in the world.

TO THE many for whom Wyandotte is an essential part of successful business operation we say, "Merry Christmas, Happy New Year and Many Thanks! We're glad to be associated with you and we hope we'll long continue to merit your confidence."

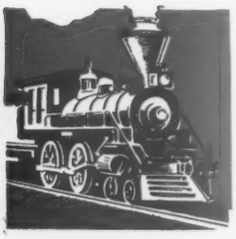
And to those of you who may not now be enjoying the efficiency and economy of Wyandotte we also say, "Merry Christmas and Happy New Year!" But we add "The New Year will be happier and more prosperous if you make Wyandotte a part of your business equipment."

It's up to us to prove it, of course. And we will, at your convenience.

Wyandotte PRODUCTS

THE J. B. FORD COMPANY
WYANDOTTE, MICHIGAN

THE "GET" OF THE



THE iron horse of days gone by has bred a noble line of thoroughbreds in the locomotives of today. Sleek, fast, clean-lined, efficient, these new engines mark a new day in railroading.

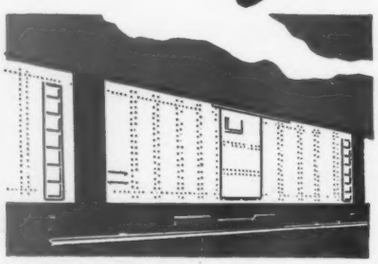
And to their development, steel has contributed much. For the designer and the metallurgist have worked hand in hand in perfecting the new equipment. USS High Tensile Steels have made possible a material lightening of many structural parts with no sacrifice in strength. Alloy steels of various chemistries have provided new strength, added impact values, greater resistance to fatigue for many parts. Rolled steel has simplified design, speeded up construction. USS Stainless Steels have brought new beauty, new longevity to equipment. In virtually every branch of railroading steel is helping railroads render a better, more dependable service to American business.

Each of the subsidiary manufacturing companies of the United States Steel Corporation is prepared to assist you with information, and with technical data to meet your needs. Please feel free to call upon them.

Light Weight at Low

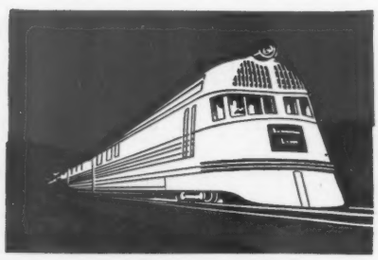
FOR TRAIN LINES

USS High Tensile Steels are used for many specialties to lessen weight and to guard against corrosion. National Cor-Ten Train Line Pipe reduced weight for this equipment on a new car by 24.2%. Doors, ends, roofs, and other units of USS Cor-Ten lower the dead weight.



FOR FREIGHT CARS

Material reductions in weight with no sacrifices in strength are possible with the new USS High Tensile Steels. A new hopper car built of USS Cor-Ten is 4 tons lighter. A new box car cuts weight 26.8% with USS Cor-Ten.

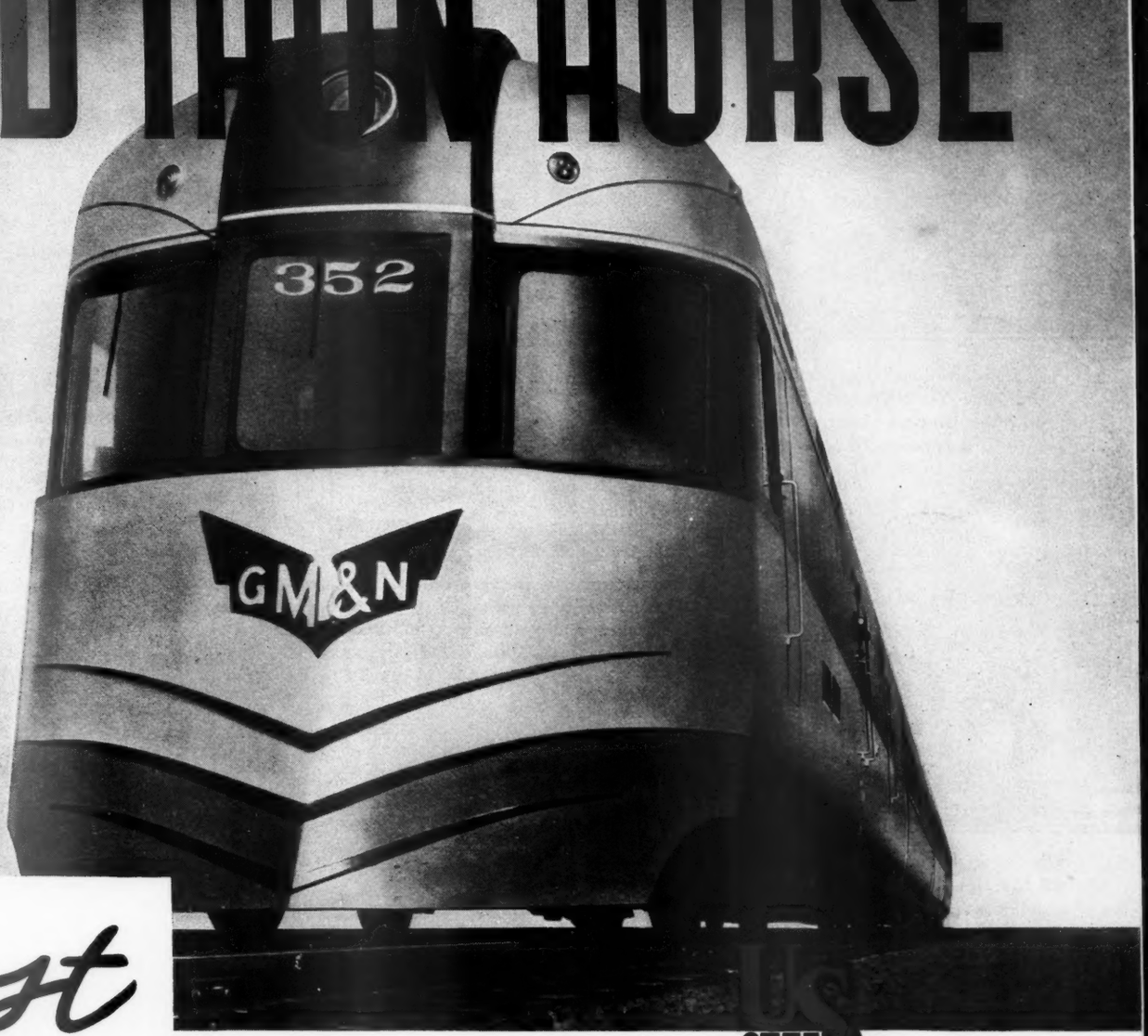


FOR THE "STREAMLINERS"

Notably successful have been some of the new streamline trains built of USS Stainless Steel (USS 18-8). Very high physicals make possible great strength with light weight and a corrosion-proof surface that makes beauty long-lived and maintenance correspondingly lower.

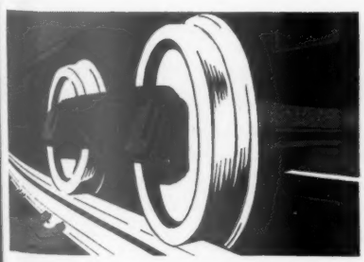
United States

OLD IRON HORSE



w Cost

USS STEEL



FOR ALL CARS

Wrought steel wheels (Carnegie and Illinois) are light in weight yet with great strength rolled in for dependability and safety. There are types for every service . . . single and multiple wear.

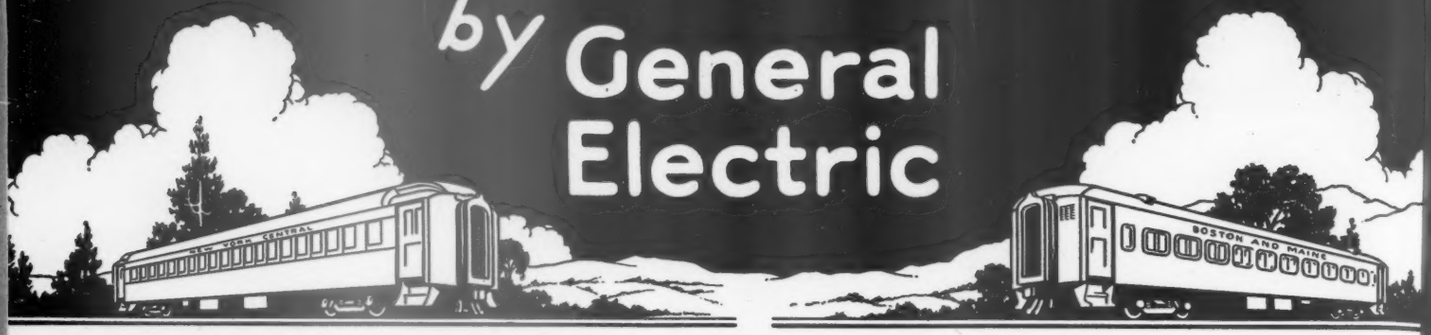
Steel structures of all classes, turntables, transmission towers and component parts • Black and galvanized sheets, automobile sheets, electrical sheets, sheets for special purposes, tin and terne plates; Keystone Rust-Resisting Copper-Steel Products; USS Stainless and Heat-Resisting Steel; USS High Tensile Steel • Wire fencing, barbed wire, wire rope, electrical wires and cables, nails, manufacturing wires, cold rolled strip steel. Springs • Concrete reinforcement • CB Sections, structural shapes, piling, plates, bars, flats, billets • Axles • Wheels • GEO Track Construction • Rails and track material • Cyclone Chain Link Fence—also lawn fence, wire screen cloth, wire belting, and wire specialties • Special Track Work and Accessories • Standard pipe, copper-steel pipe, rotary rolled pipe, electric-welded pipe, hammer-welded pipe, boiler tubes, seamless mechanical tubing, special dipped and coated pipe, cement-lined pipe, cylinders, couplings • Universal Atlas Cements.

AMERICAN BRIDGE COMPANY
AMERICAN SHEET AND TIN PLATE COMPANY
AMERICAN STEEL & WIRE COMPANY
CARNEGIE-ILLINOIS STEEL CORPORATION
COLUMBIA STEEL COMPANY
CYCLONE FENCE COMPANY
NATIONAL TUBE COMPANY
TENNESSEE COAL, IRON & RAILROAD COMPANY
UNIVERSAL ATLAS CEMENT COMPANY

SCULLY STEEL PRODUCTS COMPANY, *Warehouse Distributors*
UNITED STATES STEEL PRODUCTS COMPANY, *Export Distributors*

tes Steel USS STEEL *Corporation Subsidiaries*

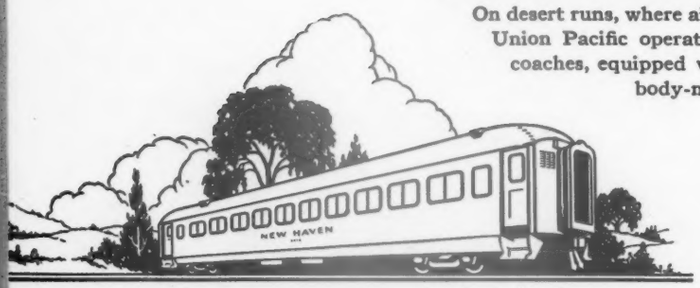
Air Conditioned by General Electric



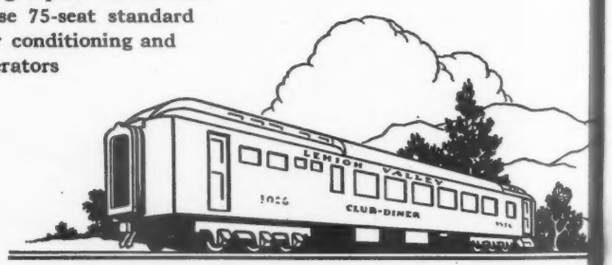
A standard coach—in regular service on the New York Central. In addition, 46 other cars on this road use G-E axle-mounted generators

A new lightweight de luxe coach, with built-in G-E air conditioning and axle-mounted generators. Ten of these cars are in main-line service on the Boston & Maine

On desert runs, where air conditioning is put to a real test. Union Pacific operates 10 of these 75-seat standard coaches, equipped with G-E air conditioning and body-mounted generators

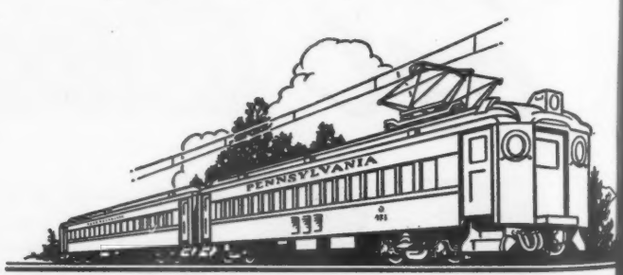


One of fifty modern, lightweight, streamlined coaches on the New Haven that are equipped with G-E air conditioning and axle-mounted generators



A standard club-diner; modernized and equipped with G-E air conditioning and axle-mounted generator. In daily service on the Lehigh Valley

On the Burlington's Diesel-electric trains, the Twin Zephyrs. Head-end power runs the G-E air-conditioning equipment. The Burlington also operates 16 G-E body-mounted generators on standard cars



G-E air conditioning on the electrified section of the Pennsylvania. This equipment, on both motor car and trailer, receives its power from the 11,000-volt overhead

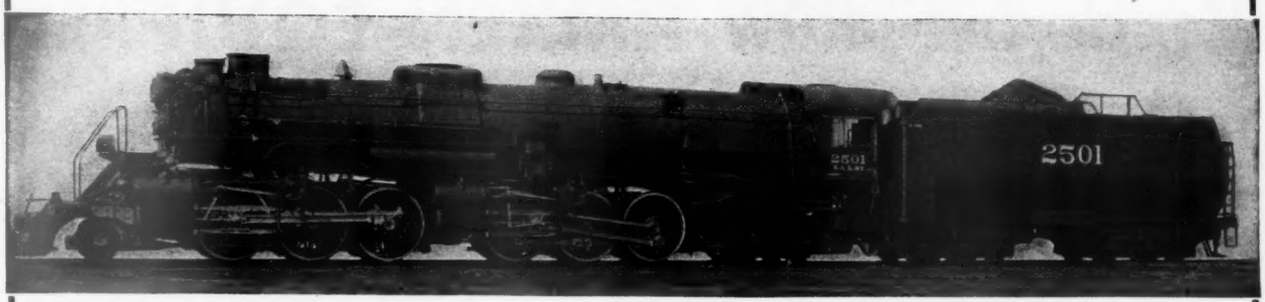
GENERAL ELECTRIC air-conditioning equipment can be furnished to fit any car—standard, lightweight, or streamlined. It can be built to take its power from the axle (with either an axle-mounted or body-mounted generator supplying power for the compressor, batteries, and lights); from the overhead on electrified sections; from a head-end power supply on Diesel-electric trains; from wayside electric circuits in terminals or yards.

Specify complete air-conditioning equipment by G. E.
General Electric Company, Schenectady, New York.

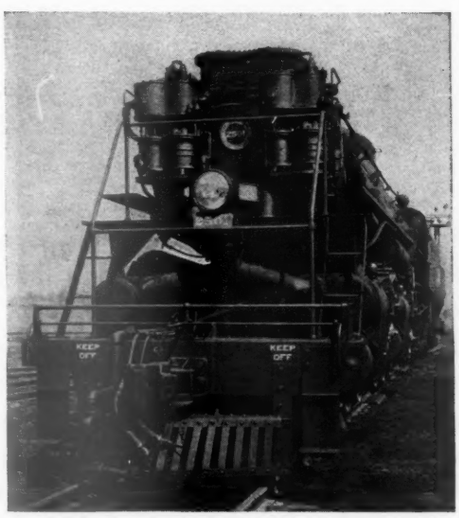
285-2

GENERAL ELECTRIC

ARTICULATED LOCOMOTIVES



SEABOARD AIR LINE



General Specifications
Cylinders (4) 22" x 30"
Steam pressure 230 lb.
Drivers diam. 69"
Weight on drivers 330,000 lb.
Weight, total engine 480,000 lb.
Weight, engine and tender 781,300 lb.
Tractive force 82,300 lb.

Early in 1935 Baldwin completed an order for five of these single-expansion articulated locomotives for the Seaboard Air Line Railway.

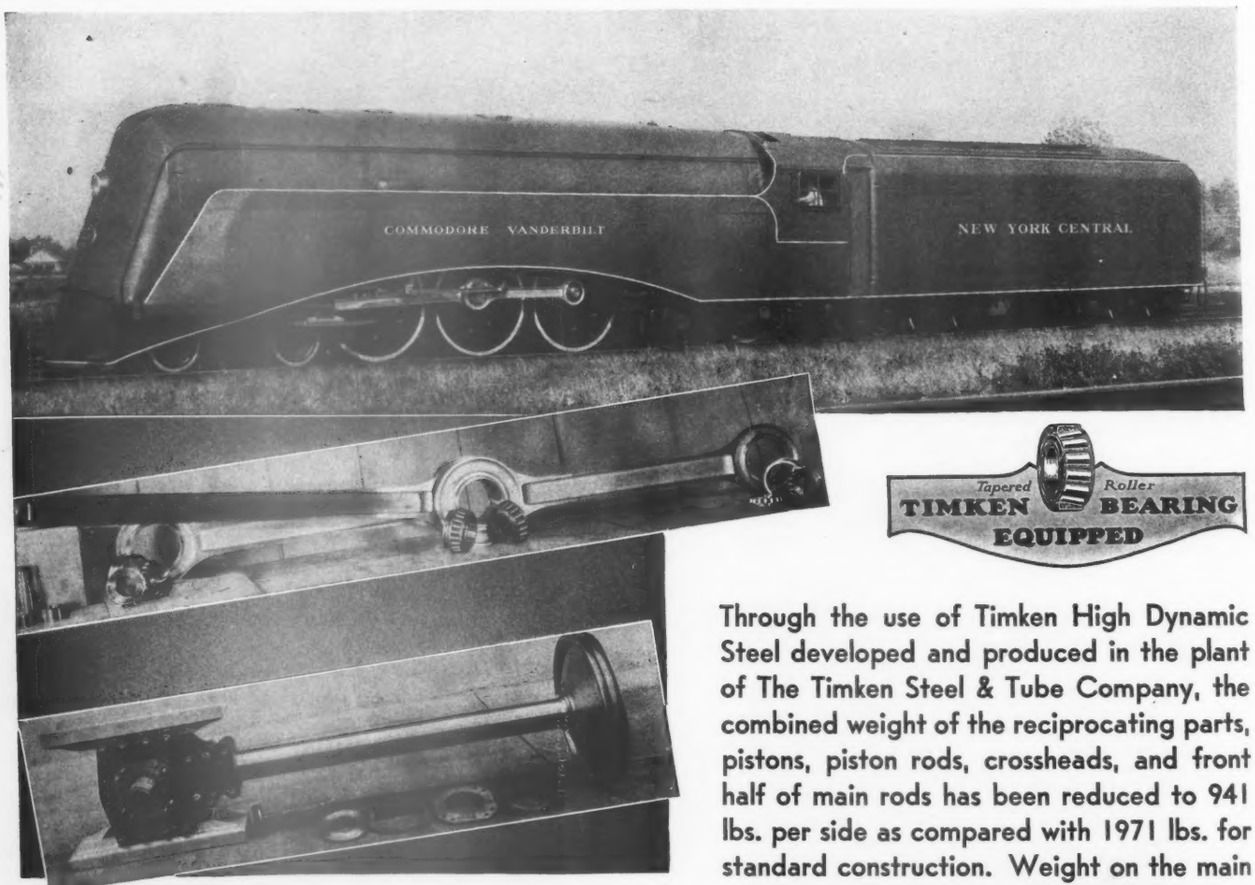
They are now operating in fast freight service on the 254 mile run between Richmond and Hamlet on the Virginia-Carolina division.

At the speeds required today, these locomotives are capable of hauling about 50 per cent more tonnage than the locomotives they replaced in this service.

It takes Modern Locomotives to make money these days!

THE BALDWIN LOCOMOTIVE WORKS
PHILADELPHIA, PENNA.

MAIN AND SIDE RODS OF THE "Commodore Vanderbilt" NOW TIMKEN-EQUIPPED



Tapered Roller TIMKEN BEARING EQUIPPED

WITH the installation recently of Timken Bearing Equipped main and side rods and crossheads, the New York Central's streamlined "Commodore Vanderbilt" became completely Timken-equipped with the exception of the trailer truck. This locomotive was previously equipped with Timken Bearings on the engine truck axles, driving axles and tender truck axles, and these bearings have made over 480,000 miles. The application of Timken Bearings to the rods and reciprocating parts is not the only interesting feature.

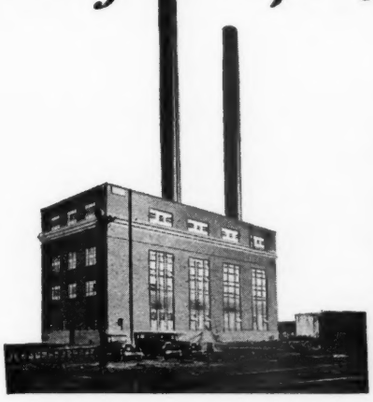
Through the use of Timken High Dynamic Steel developed and produced in the plant of The Timken Steel & Tube Company, the combined weight of the reciprocating parts, pistons, piston rods, crossheads, and front half of main rods has been reduced to 941 lbs. per side as compared with 1971 lbs. for standard construction. Weight on the main crank pin has been reduced 354 lbs. or 22%. The front half of the Timken Main Rod weighs only 207 lbs.—less than half the weight of standard construction. This weight reduction has been made without sacrificing strength. On the contrary, the new light weight parts are actually stronger than the old heavy parts. The actual weight of the Timken Main Rod is 485 lbs. and the Timken Side Rods weigh 287 lbs. each. The "Commodore Vanderbilt" has now gone back into regular service. Its future performance will undoubtedly be watched with renewed interest.

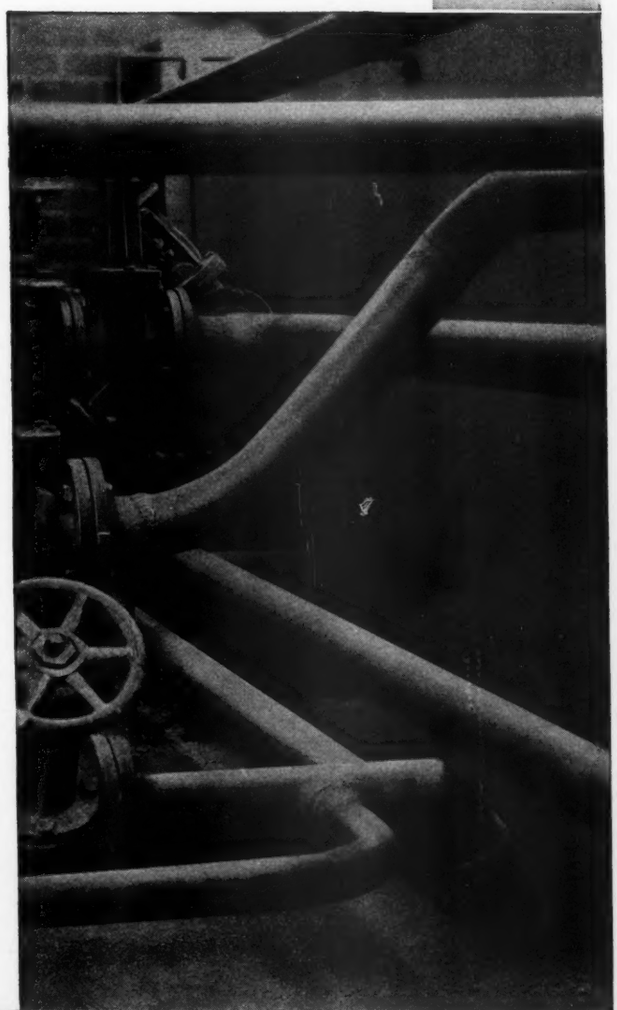
THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

TIMKEN *TAPERED ROLLER* **BEARINGS**

OXWELDING PROVIDES—

permanently leakproof piping at low cost





● Many advantages—strength, ductility, ease of installation, simplified insulation, convenience of making alterations, high efficiency, and low cost—make oxwelded piping particularly adaptable to the railroad field.

The Oxweld Railroad Service Company has sponsored research in the field of oxwelded piping which has resulted in the development of efficient procedures for making strong, leakproof lines in all types of metals, for all types of piping services. Complete information and instruction is available for interested Oxweld clients.

For almost a quarter of a century Oxweld Railroad Service has been providing for the majority of the Class I railroads, Oxweld procedures for the efficient and profitable use of the oxy-acetylene process.

THE OXWELD RAILROAD SERVICE COMPANY
Unit of Union Carbide and Carbon Corporation
UCC
NEW YORK—Carbide and Carbon Building
CHICAGO—Carbide and Carbon Building

OXWELD RAILROAD SERVICE

● HIGH SPEED AND STRENGTH AT LOW COST. Improved methods recently introduced have increased the speed of welding together lengths of pipe, made installation easier, and substantially reduced the cost. Railroads can profit by extending the use of oxwelding for new pipe line construction and for pipe maintenance.

Good Mechanical Department Books

A New British Book

Diesel Locomotives and Rail Cars

By BRIAN REED

The latest book on Diesel traction in which operating results of many types of Diesels are surveyed on railroads in many countries. The book is well illustrated with photographs and line drawings and there are tables showing comparative operating costs of Diesel and steam locomotive, using cheap fuel oil.

198 pages, 131 illus., 5½ x 9, cloth, $2.50

New Safety Appliances

United States Safety Appliances

This is the 14th or 1935 edition of the official A. A. R. book in a waterproof imitation-leather binding. It contains safety appliances for all classes of cars and locomotives with changes in laws and ruling since the previous edition published in 1928. Included are the latest classification of defects to be reported to the Interstate Commerce Commission.

120 pages, 49 scale drawings, 7½ x 3¾, flexible, $1.00

Ready January 20th

Trains, Tracks and Travel

By T. W. VAN METRE
Professor of Transportation, Columbia University

This story of railroading in all its branches is for young people and others who are not well acquainted with the subject. The book has gone through three editions. The fourth, with an added chapter on streamlined trains, will be ready shortly. Air conditioning, the new AB brake equipment and other changes which have occurred since 1931 have been added to chapters to bring them up to date. The many illustrations are from "Railway Age."

306 pages, 250 illus., 6 x 9, cloth, $3.00

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Locomotive and Boiler Inspector's Handbook

By A. J. O'NEIL
Locomotive Inspector, Transit Commission of the State of New York

This book furnishes information for anyone who wishes to pass an examination for the position of locomotive or boiler inspector. Included are 162 questions which might well form the basis of an inspector's examination. All Federal laws, rules and requirements of the Interstate Commerce Commission are included.

297 pages, 140 illus., 5 x 8, flexible, $2.50

Locomotive Valve Setting

By JACK BRITTON
Valve Setting Specialist

The author explains the usually carefully guarded secrets of valve setting. In natural sequence, with the aid of simple drawings and without puzzling mathematical formula, he shows how to follow most any "stunt" that the practical locomotive shopman may run into.

350 pages, 210 illus., 5 x 7½, flexible, $3.00

Air Brake Inspector's Handbook

By CARL O. GLENN
Air Brake Engineer

This book covers all the new air brake equipment except the ET and AB freight brake. Special treatment is given to defects, tests and remedies of air brake apparatus. Air brake inspectors, freight and passenger car inspectors, enginemen, machinists and carmen assigned to air brake repair and car shop foremen will find this book very useful.

328 pages, 110 illus., 5x7½, flexible, $3.00

Practical Railway Painting and Lacquering

By H. HENGEVELD, C. P. DISNEY and W. J. MISKELLA

Every phase of railway painting is discussed. The use of the spray-gun is explained in detail, and cost charts of new and old methods are a feature. One table shows the characteristics of various glazing and mixing knives. There is a chapter on sand blasting which includes information on all grades of sandpapers.

267 pages, 164 illus., 22 charts, 6 x 9, Fabrikoid, $3.50

Railway Fuel

By EUGENE McAULIFFE
President of Union Pacific Coal Company

This is the only book which completely covers the railway fuel problem. The coal industry is described in its relation to the transportation and use of coal and coal substitutes such as oil, by the steam railroads. The text is supplemented by charts and tables.

480 pages, 86 illus., appendices, 6 x 9, cloth, $5.00

This One Tool Steel

handles many railway-shop jobs

RAILWAY shop-men who use Bethlehem Omega handle many different jobs with this single grade of high-performance alloy tool steel.

Omega is primarily an impact-resisting steel, combining extremely high tensile strength with great toughness. It is unmatched for tools subject to the battering of pneumatic hammers. Pneumatic and hand chisels, rivet sets, blacksmith tools, rivet busters, beading tools and punches made of Omega Steel bear up under punishment that no tool steel, lacking Omega's toughness and stamina, could survive.

Omega's high properties make it also an excellent steel for shear blades. Many shops have standardized on it for this purpose.

Using Omega for all these tasks not only provides better tools that last longer and work faster, but also reduces the number of grades of steel that must be stocked, and simplifies heat-treating. One standard procedure covers a wide range of tools.

Heat-treated, Bethlehem Omega Tool Steel develops a tensile strength of 340,000 lbs. per sq. in. in combination with an Izod value of 7 ft.-lbs. If greater toughness is needed a slightly higher drawing temperature runs the Izod value up to 15 ft.-lbs. with only a trifling reduction of tensile strength, to 320,000 lbs. per sq. in.

Omega Steel is readily forged at about 1750 deg. F. In heat-treatment it responds to a wider temperature range than carbon steels. No expensive equipment is needed.

On the following page are listed other Bethlehem Tool Steels, each an outstanding performer in its field.

Whatever the Job, you'll find a grade of

BETHLEHEM TOOL STEEL

that is just right for it

BETHLEHEM SPECIAL HIGH-SPEED TOOL STEEL
Bethlehem Special High-Speed Tool Steel is used for lathe, planer, boring, slotting, shaping and other roughing tools. It is also used for twist drills, milling cutters, taps, reamers, gear cutters, inserted saw teeth, inserted milling-cutter teeth, special dies, woodworking tools, punches, and threading dies.
At forging heat this steel can be readily formed into shapes necessary for making intricate tools. Its properties are such that it can be easily annealed.

BETHLEHEM EXTRA-SPECIAL HIGH-SPEED TOOL STEEL
Bethlehem Extra-Special High-Speed Tool Steel is an outstanding steel for use where superservice is demanded. It is particularly well adapted for machining heat-treated alloy steels, brass, bronze or steel castings, extrusion dies and dummy blocks and for all other unusually heavy-duty work.

BETHLEHEM FINISHING TOOL STEEL
Bethlehem Finishing Tool Steel is an alloy water-hardening tool steel which is recommended for the following:
Chilled-roll and brass turning tools; master tools and taps; milling cutters; reamers; cutters for finish-reaming, boring and rifling guns; automatic screw-machine forming tools; threading tools, chasers and dies; burnishing dies; cold-drawing dies and mandrels for cold-drawing high-speed and carbon tool steels; brass, bronze, copper and steel tubing and bars.

BETHLEHEM XXX SPECIAL TOOL STEEL
Bethlehem XXX Special Tool Steel is the very best grade of carbon finishing tool steel. It may be used for all purposes for which Bethlehem Finishing Tool Steel is recommended and will give equally good results if the cutting speeds are reduced to meet conditions.

BETHLEHEM SUPERIOR TOOL STEEL
Bethlehem Superior Tool Steel is a carbon-vanadium tool steel, combining all the characteristics of a straight-carbon tool steel with better physical properties, greater resistance to fatigue, and superior cutting qualities.

BETHLEHEM XX TOOL STEEL
Bethlehem XX Tool Steel is a general-purpose tool steel of extra-fine quality. This steel is carried in stock in all tempers, suitable for the following: taps and reamers, milling cutters, punches, stamping and blanking dies, broaches, blacksmiths' tools, boilermakers' tools, granite and mining drills and tools, wood-working tools, shear blades, chisels, rivet sets, drop-forging dies, cold-heading bolt and rivet dies, threading dies, headers, trimming dies, and cold-drawing dies.

BETHLEHEM XCL TOOL STEEL
Bethlehem XCL Tool Steel is recommended for all purposes requiring a uniform and reliable yet comparatively inexpensive grade of steel. This steel is used for the following: collets, cups, cones, drop-forging dies, trimming dies, mining and quarrying tools, blacksmiths' tools, fullers, flatters, cold cutters, track tools, boilermakers' tools, hand and pneumatic chisels, caulking and beading tools, rivet sets, punches and dies, shear blades, and machine parts that require hardening.

BETHLEHEM X TOOL STEEL
Bethlehem X Tool Steel is an inexpensive grade of straight-carbon tool steel which many users find very satisfactory for a wide variety of purposes.

BETHLEHEM TOOL ROOM OIL-HARDENING TOOL STEEL
Bethlehem Tool Room Oil-Hardening Tool Steel has been developed especially for use in the tool room in making master tools, dies, intricate pieces, and work of a similar nature. It is particularly adapted to this class of service because of non-warping and non-shrinking qualities, combined with hardness and toughness. It hardens and anneals uniformly.
This steel is recommended for use in making punching, blanking, trimming, sub-press, forming and drawing dies; taps; reamers; broaches; circular cutters; hobs; master tools of all kinds; plug, ring thread, and service gauges of a variety of forms.

BETHLEHEM No. 71 ALLOY STEEL
Bethlehem No. 71 Alloy Tool Steel is recommended for hand and pneumatic chisels; for punches and shear blades used for cutting scrap, plates, sheets; for set screws and other heavily-stressed machinery parts which must be hardened.

BETHLEHEM TOUGH TOOL STEEL
Bethlehem Tough Tool Steel is a chrome-vanadium steel possessing a high degree of hardness and toughness. It is water-hardening, and is recommended for use in making cold cutters, flogging chisels, rivet and button sets, hand and pneumatic chipping chisels, shear blades, punches and similar tools.

BETHLEHEM LEHIGH DIE AND TOOL STEEL
Bethlehem Lehigh Die and Tool Steel is a high-carbon, high-chromium steel. This steel possesses unusual hardening qualities when hardened in oil or air and is especially well adapted to maximum production service. It also possesses non-warping and non-shrinking properties which make it particularly desirable for punch-and-die work where freedom from distortion is necessary. It has exceptional machinability for this type of steel.

BETHLEHEM OMEGA TOOL STEEL
This tool steel possesses an exceptional combination of strength and toughness which makes it an outstanding impact-resisting steel. Bethlehem Omega Tool Steel is used in pneumatic chisels, rivet sets, blacksmiths' tools, rivet busters, beading tools, punches, pipe-cutter wheels, and in practically all other tools which are subjected to drastic repeated impacts at reasonably low temperatures.

BETHLEHEM No. 57 HOT-WORK TOOL STEEL
Bethlehem No. 57 Hot-Work Tool Steel is a chrome-tungsten steel, especially developed for hot-work tools. This steel possesses exceptional toughness and hardness when working hot metal, which enable it to resist remarkably well the battering action of the header in the hot-heading of bolts and rivets. It is recommended for the following purposes: hot-bolt, rivet and spike heading gripper or open dies and headers, hot-nut crowners, piercers and punches, hydraulic riveter dies, bull-dozer dies, compression dies, shear blades, and hot chipping chisels.

BETHLEHEM No. 445 HOT-WORK TOOL STEEL
Bethlehem No. 445 Hot-Work Tool Steel is a chrome steel, developed for the same purposes as Bethlehem No. 57 Hot-Work Tool Steel. It has been found equally satisfactory, except where the duty is abnormally severe or when the tool is subjected to unusually high temperatures.

THESE 5 PROCESSES RESULT IN SUPERFINE TOOL STEEL

QUALITY TOOL STEELS never "happen." The superfine quality of Bethlehem Tool Steels is built up, step by step, with infinite care and patience, throughout manufacture. Each process followed is representative of the most advanced steel-making practice. The result is inevitable: Tool Steels so uniformly fine as to bring marked economies wherever they are used.

HIGH-FREQUENCY INDUCTION MELTING
Bethlehem Tool Steels get the right start by melting in the high-frequency electric induction furnace, which makes steel to laboratory standards of accuracy.

LIBERAL INGOT DISCARD
Large discards, from both the top and bottom of the ingot, mean that the buyer gets only the "cream" of the tool steel.

HAMMER-COGGING OF INGOTS

It's far costlier to hammer-cog ingots than to roll them. But the tremendous impact developed under the 14,000-lb. hammer insures a complete working of the entire ingot and the breaking up of all undesirable ingot structure.

PROGRAM-CONTROLLED ANNEALING
The exact heating, soaking and cooling curve desired is obtained by a motor-driven cylinder on which the edge of a plate guides the temperature regulator. Possibilities of human error are eliminated.

RIGOROUS INSPECTION

Thoroughly representative cross-sections for inspection are obtained by cutting slabs from the tool-steel billet stock before rolling, and cutting discs from the finished bars. These samples are subjected to hot-acid etch, hardenability tests, and microscopic examination.

Bethlehem District Offices: Atlanta, Baltimore, Boston, Bridgeport, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Houston, Indianapolis, Kansas City, Milwaukee, New York, Philadelphia, Pittsburgh, San Antonio, St. Louis, St. Paul, Washington, Wilkes-Barre, York. *Pacific Coast Distributor:* Pacific Coast Steel Corp., San Francisco, Los Angeles, Seattle, Portland, Salt Lake City, Honolulu. *Export Distributor:* Bethlehem Steel Export Corp., New York.

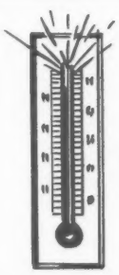
BETHLEHEM STEEL COMPANY

GENERAL OFFICES: BETHLEHEM, PA.

GARLOCK 7021

COMPRESSED ASBESTOS GASKET SHEET

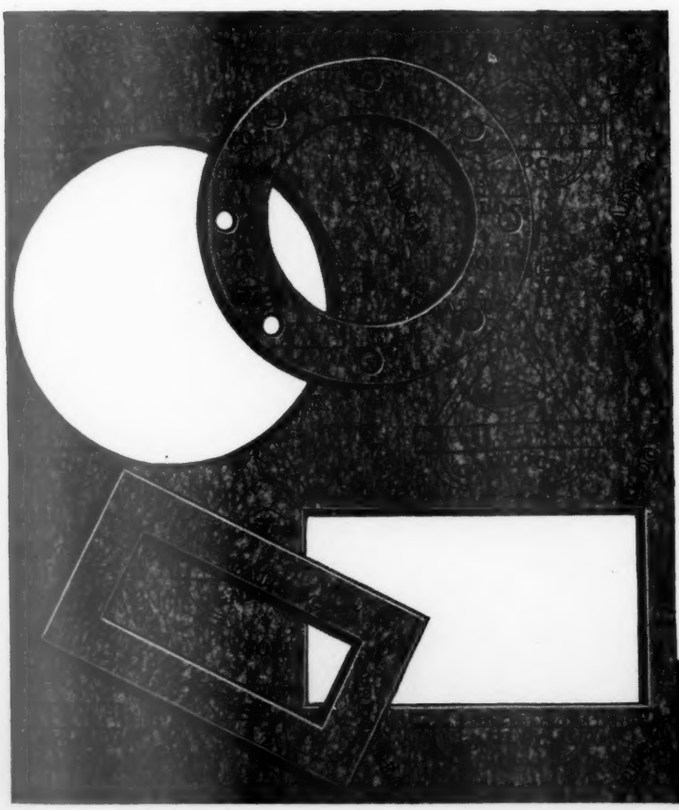
for



HIGH TEMPERATURES

EXTREME PRESSURES

GASOLINE **OIL** **GAS** **STEAM**



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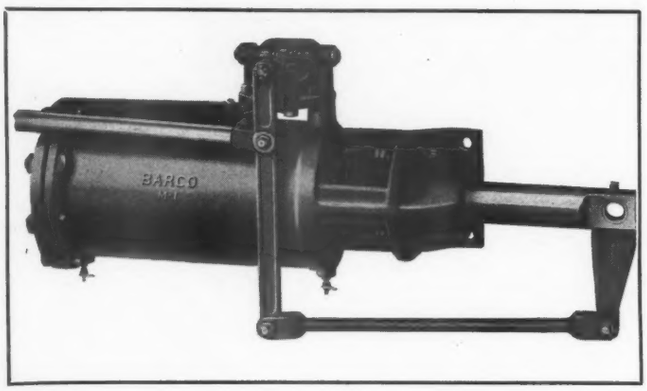

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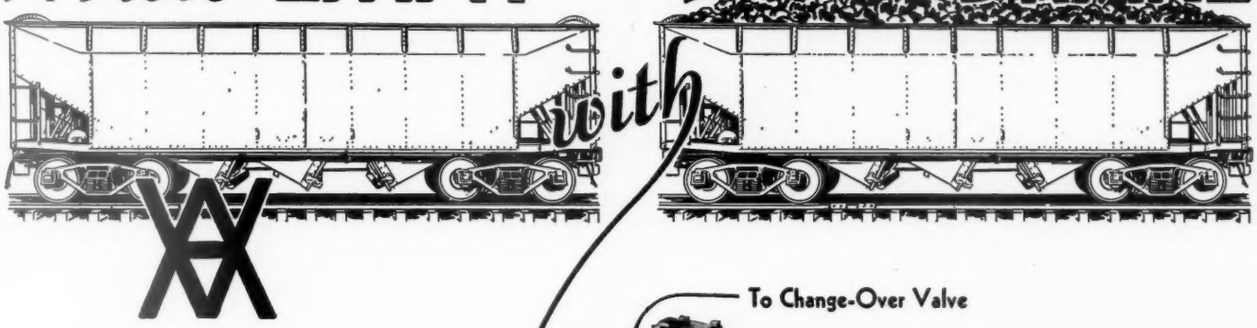

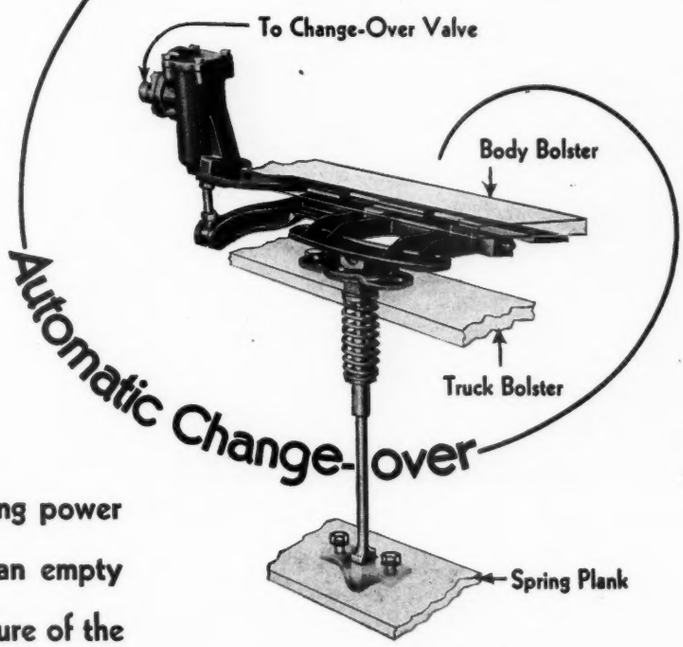

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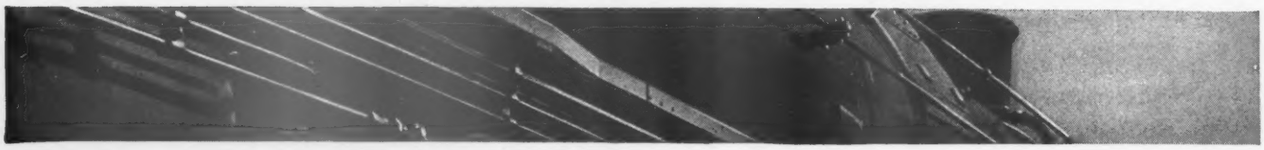

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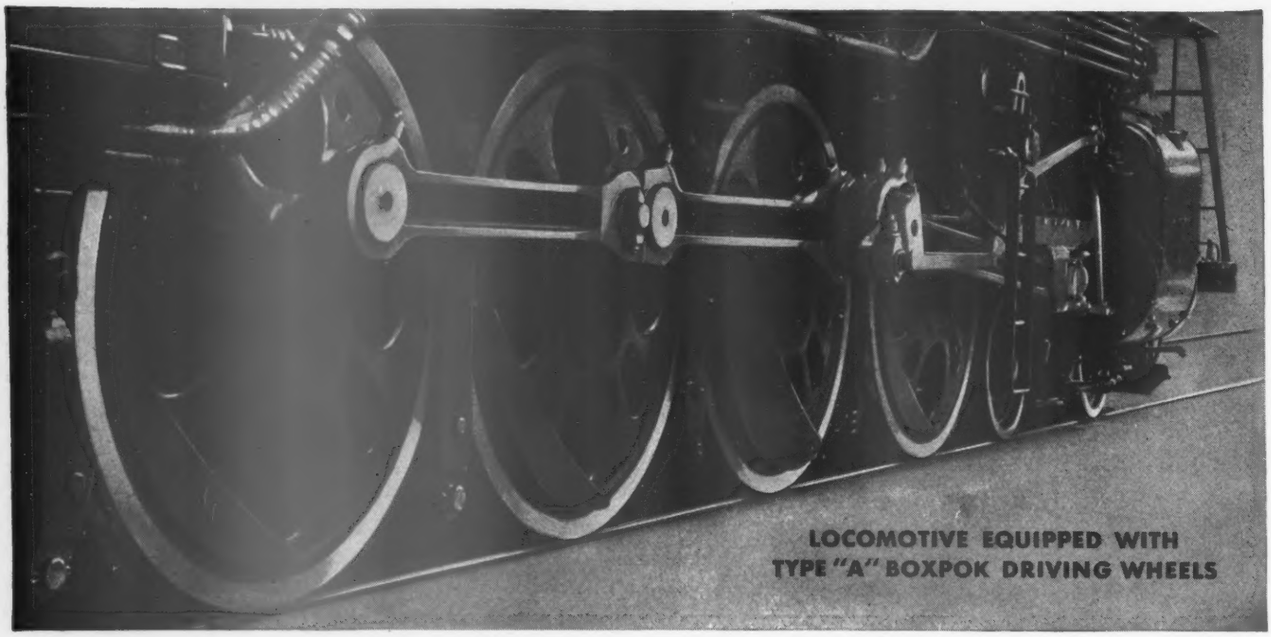

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VOL. 109 No. 12

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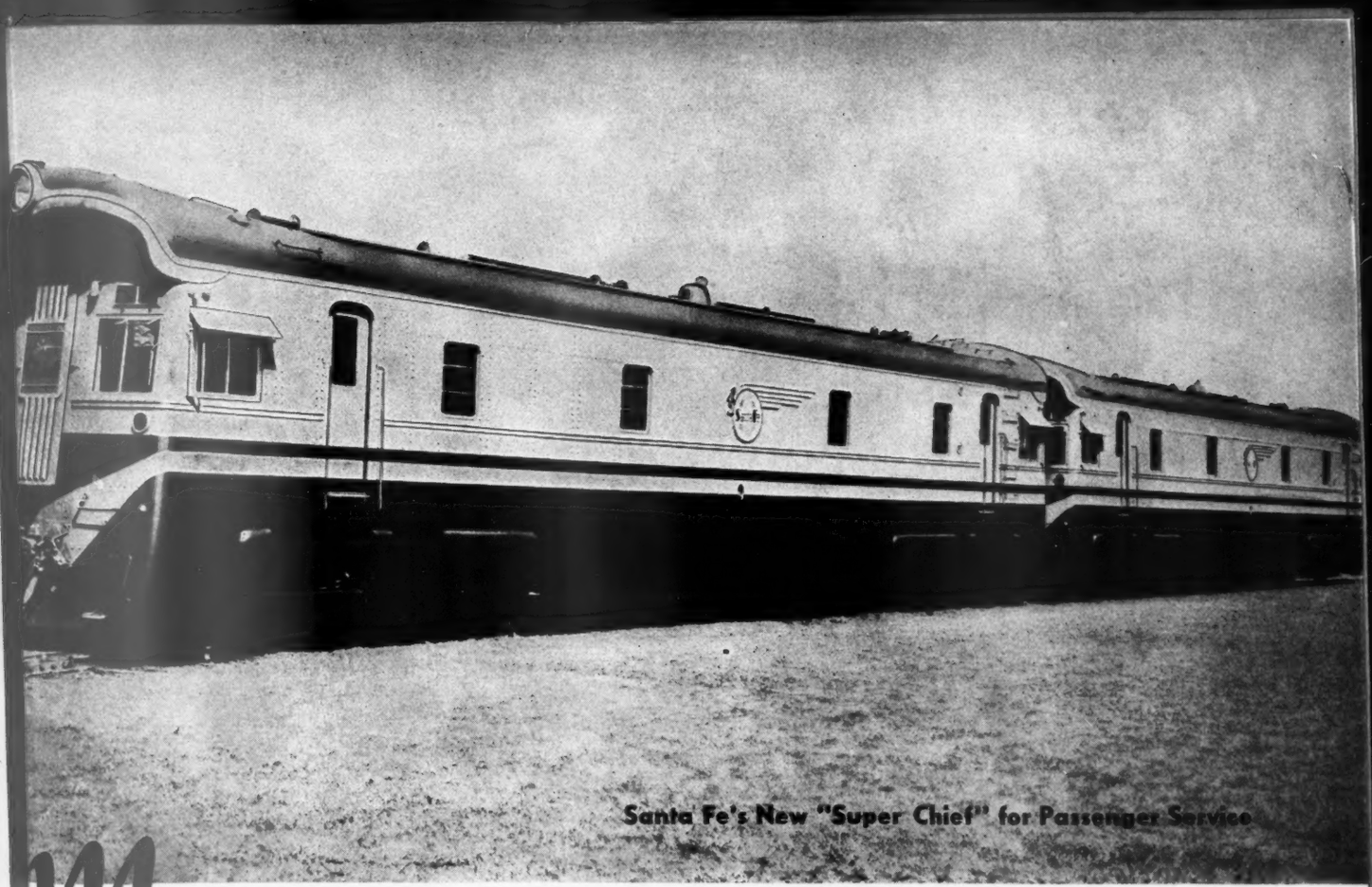

Santa Fe's New "Super Chief" for Passenger Service

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IN keeping with recent advances in railroading, the Santa Fe is planning to place this 3600-hp Diesel-electric locomotive in passenger service between Chicago and Los Angeles, in order to reduce the running time. On the basis of known performance of its gas-electric rail cars and Diesel-electric locomotives, the Santa Fe expects similar benefits from this new locomotive, including savings in operating expense and greater availability, besides an increase in traffic due to the faster schedules. The new "Super Chief" has General Electric equipment.

In 1927, after 14 years of experience with electric drive, the Santa Fe officials were convinced that this type of motive power has a definite place in their service. By 1932, they had 33 G-E equipped cars and switchers in operation, including a 900-hp distillate-electric car, the largest built to date. These motor cars have been maintaining regular schedules with one-, two-, and three-car trains.

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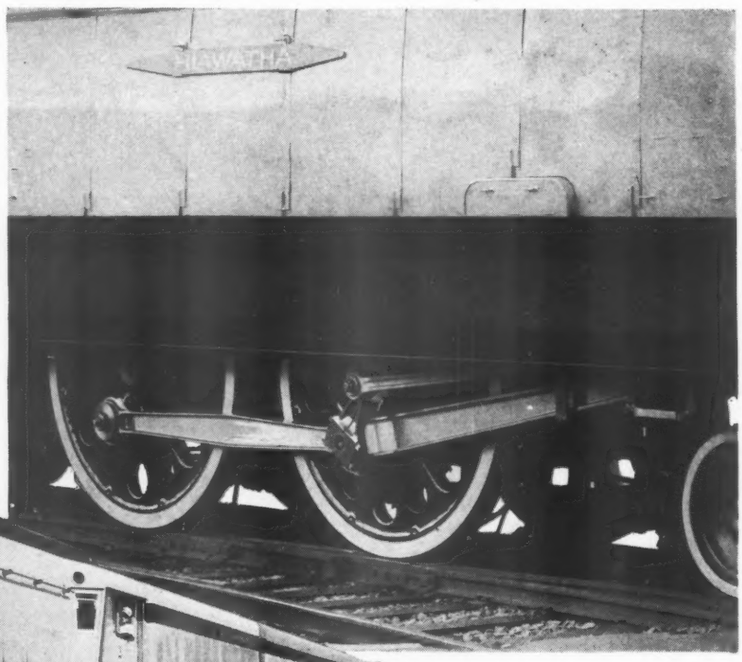

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